Twentieth Report of the Ontario Bureau of Mines

Parts I. and II.

1911

TWENTIETH ANNUAL REPORT

OF THE

BUREAU OF MINES, 1911,

BEING

VOL. XX., PART I.

CONTENTS:

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LETTER OF TRANSMISSION

To His Honour John Morison Gibson, Etc., Etc., Etc.,

Lieutenant-Governor of the Province of Ontario:

Sir,—I have the honour to transmit herewith for presentation to the Legislative Assembly of the Province of Ontario, the Twentieth Annual Report of the Bureau of Mines.

I have the honour to be, Sir,
Your obedient Servant,

F. Cochrane,
Minister of Lands, Forests and Mines.

Department of Lands, Forests and Mines.
Toronto, 27th February, 1911.

INTRODUCTORY LETTER

To The Honourable Frank Cochrane,
Minister of Lands, Forests and Mines.

Sir,—I beg to hand you herewith to be presented to His Honour the Lieutenant-Governor in Council, the Twentieth Annual Report of the Bureau of Mines, comprising two parts.

The Report covers, speaking generally, the year 1910, but where information pertaining to the period elapsing between the close of the year and the publication of the Bureau's annual volume is available, it has always been the practice to make use of it. In 1909 the fiscal year of the Province was made to end on the 31st day of October, and the statements of revenue given in the Bureau's Reports since that time have been for the fiscal instead of for the calendar year as formerly. Statistics of production, however, continue to be for the twelve months ending 31st of December.

Part I. of the Report opens with the usual statistical review of the Province's mining industry for the preceding year. Tables are given showing the output in quantity and value of the various metals and mineral substances, with corresponding figures for preceding years, so that comparisons may be made, and the rate of progress, or the reverse, noted. The aggregate production for 1910 much exceeded that of any former year, the gain in value over 1909, previously the record year, being upwards of six millions of dollars. The silver mines of Cobalt, which have placed Ontario in the position of the third largest producer of silver in the world, increased their output by four and three-quarter millions of ounces, and the nickel mines of Sudbury, now recognized as the most important source of this metal, by 5,495 tons. Other important products, both metallic and non-metallic, show considerable advances, and while there have been a few decreases, the production tables on the whole give evidence that the mining industry of Ontario is undergoing a steady and rapid growth. The field, too, is widening. The yield of gold has never been great in this Province, and it has at times seemed as if gold production was about to cease entirely. Developments at Porcupine, however, afford good ground for hoping that Ontario will yet make an appreciable contribution to the gold output of the Dominion.

The revenue derived by the Government from mining sources is now considerable. In 1910, it amounted to $941,030.09, and tables are given showing the items of which this total is composed. Particulars are also presented regarding the mining companies incorporated and licensed during the year, the work of the Provincial Assay Office, Mining Recorders, etc., and there are tables of fatal and non-fatal accidents. Mr. E. T. Corkill, Chief Inspector of Mines, deals with the whole subject of mining accidents, among other things indicating the directions from which a much-needed improvement over the present state of things may be expected to come.

Mr. Corkill describes the Mines of Ontario, and gives details concerning the development work in the various properties as noted by him in his visits of inspection for the purpose of seeing that the regulations for the safety and health of mine employees, provided by the Mining Act of Ontario, are duly observed. The silver mines of Cobalt are not dealt with by Mr. Corkill, as these will be covered by the fourth edition of Dr. W. G. Miller's Report on the Silver Districts of Ontario, the publication of which has been somewhat delayed. This Report will be Part II. of the Nineteenth annual volume.

A number of years ago silver mining was actively carried on in the region west of Port Arthur, but of late little or nothing has been done there, and most of the mines have been long idle. The interest aroused by the silver camps of northeastern Ontario—Cobalt, Gowganda, etc.—has led to more or less inquiry regarding the older field, and the prospects of re-opening some of the properties formerly productive, or of discovering new deposits. Mr. N. L. Bowen was commissioned to re-examine and report upon the area, and his observations are published in Part I. under the heading "Silver in Thunder Bay District," the report being illustrated by a geologically colored map.

Mr. Bowen has also compiled some useful notes on the Salt Industry of Ontario, and briefly describes the processes employed in the procuring and manufacturing of that article.

As Cobalt has stimulated interest in the old silver mines of Ontario, so have the gold discoveries at Porcupine given rise to a demand for information regarding the older gold districts of the Province, the Bureau's Reports dealing with which are for the most part out of print. The Sturgeon Lake Gold Field was visited by Dr. E. S. Moore, in 1909, and again in 1910, and the Gold Fields of Lake of the Woods, Manitou and Dryden in the latter year by Mr. Arthur L. Parsons. Their respective reports will be found in Part I. and are accompanied by geological maps.

Dr. Moore also reports on the Iron Pyrite Deposits at Vermilion Lake, near the line of the Transcontinental railway, and not far from Lake Minnietakie. Some of these deposits have recently been developed, and from their size, and the quality of the ore, are likely to provide shipments on a considerable scale. As an appendix, Dr. Moore makes a short report on the Tip Top Copper mine, near Round Lake.

Newspaper reports having again alleged the discovery of bituminous coal on the Hudson Bay slope, Prof. M. B. Baker, of Queen's University, Kingston, was asked to investigate them. The results of this exploration are embodied in Prof. Baker's Report on Iron and Lignite in the Mattagami Basin. The finds proved to be of lignite of the kind which has long been known to exist in that region, the usefulness of which is likely to be confined to the locality in which the deposits occur. Prof. Baker at the same time examined the iron ore deposits at Grand Rapids on the Mattagami river, discovered by Dr. Robert Bell in 1875, and his report thereon will be found of interest. Owing to the over-burden of earth on the river banks, the dimensions of these deposits have not been definitely ascertained, but they are apparently of importance. Prof. Baker regards them as due to the oxidation of siderite of Animikie age, which he believes to exist at many other places along the edge of the Paleozoic coastal plain. He points out that the siderite which is exceptionally high in quality, might itself be used as an iron ore.

Prof. W. G. Miller, Provincial Geologist, contributes to Part I., Notes on a Geological Trip in Scotland, and makes an instructive comparison between the Pre-Cambrian formations of the Scottish Highlands and those of Ontario. A notable difference is that whereas the Pre-Cambrian of Ontario is pre-eminently mineral-bearing, in Scotland it is apparently barren of economic minerals.

Dr. Miller and Mr. Cyril W. Knight, Assistant Provincial Geologist, treat briefly of the Laurentian System, and particularly of the banded gneisses and their geological relationships.

Mr. S. Price, Mining Commissioner, deals with the Mining Law of Ontario, on which he is well qualified to speak. Mr. Price gives a historical sketch of the various regulations and statutes preceding the present law, and a thorough exposition of the latter, which will be found useful to prospectors, legal practitioners and others, to whom an accurate acquaintance with the Mining Act is necessary.

Part II. contains a description of the geology and mineralogy of the Porcupine Gold Area, by Mr. A. G. Burrows, of the Bureau's Geological staff. Mr. Burrows' Report is accompanied by a geologically coloured map of the Porcupine Gold Area with copious marginal notes, on a scale of one mile to an inch, and also by a map showing the geology of part of the territory lying between Porcupine and Gowganda.

In Part II. there is also a description of the Alexo Nickel deposit on lot 1, in the third concession of Dundonald township, by Mr. E. L. Uglow.

I have the honour to be, Sir,

Your obedient servant,

THOS. W. GIBSON,

Deputy Minister of Mines.

DEPARTMENT OF LANDS, FORESTS AND MINES,
Toronto, 27th February, 1911

REPORT OF THE BUREAU OF MINES 1911

VOL. XX PART I

STATISTICAL REVIEW

By Thos. W. Gibson, Deputy Minister of Mines

Returns to the Bureau of Mines under the Mining Act of Ontario show that the products of the mines and mineral works of the Province for the twelve months ending 31st December, 1910, had a value of $39,313,895. For 1909 the value was $32,981,375, the increase for the year being thus $6,332,520, or over 19 per cent. As compared with 1908, the increase was $13,676,278, or 53 per cent.

During the last few years, the advance in production has been very marked, as the following figures make plain:—

Year.	Value of Production.
1905	$17,854,296
1906	22,388,383
1907	25,019,373
1908	25,637,617
1909	32,981,375
1910	39,313,895

The only year during this period which did not show a substantial gain over its predecessor was 1908, when there was a slackening in the rate of progress, due to a lessened output of nickel, pig iron, Portland cement and petroleum. The total increase during the term was 122 per cent.

Previous to 1905, the non-metallic list provided the larger share of the production, but owing to the very decided developments in silver and nickel, the metals have come to be responsible for nearly three-fourths of the entire value, the proportions in 1910 being, metals 72 per cent., non-metals 28 per cent. Metals rose from $10,201,010 in 1905 to $28,161,678 in 1910, and non-metals from $7,653,286 to $11,152,217.

For 1910 all the metallic products, save cobalt, iron ore and zinc ore, show an increased output as compared with 1909, the principal advances being in silver, $3,016,600, nickel, $1,215,163, copper, $217,088, pig iron, $673,890. In non-metals, brick (common) shows an excess of $458,140, stone of $301,396, Portland cement of $246,995, and natural gas, $303,060. Drain tile fell of $45,106, pressed brick, $31,975, and petroleum, $191,325. The items contributing most largely to the output for the year were, silver, 39 per cent., pig iron, 17 per cent., nickel, 10 per cent., Portland cement, 8 per cent., brick, 7 per cent., natural gas, 4 per cent., copper, 3 per cent. The remainder, say 12 per cent., was provided by 24 other products, largely non-metallic.

Development of the Mining Industry

The tables which follow exhibit the mining industry in its various departments, and afford opportunities for studying its development. The statistician is rarely justified in venturing on the realm of prophecy, but the upward tendency of the curve described by the growth of mining in Ontario points strongly to still greater things in the future. It can hardly be doubted that the extension of prospecting into northern Ontario, now being rendered possible through railway construction, will bring to light new mineral fields probably as rich as any that have yet been found. The discovery of one such field leads almost as by a law of nature to the discovery of others. Silver

Islet led to Rabbit Mountain and Beaver; Copper Cliff and Stobie to Creighton and Crean Hill and Garson; the Helen mine to the Josephine and Magpie; Sultana to Mikado; Cobalt to South Lorrain and Gowganda, and latest of all to Porcupine. Nor do the pre-Cambrian formations possess a monopoly of mineral wealth; the Devonian and Silurian strata of southwestern Ontario have for years yielded goodly supplies of petroleum, natural gas, salt and gypsum. Petroleum may be declining in production, but that there are reservoirs, great or small, yet untouched, seems to be shown by the striking of oil in paying quantities a short time ago in Onondaga township, and the field for profitable production of natural gas appears to be steadily widening until it promises to cover a large part, if not the whole, of the northern and eastern shores of lake Erie. These stratified rocks have their counterparts on the slope leading down to James bay. Already gypsum in large deposits has been located there, and it would seem not unreasonable to entertain the hope that the future inhabitants of the clay belt north of the height of land may find it possible to light their homes with oil, cook their food with natural gas, and cure their pork with salt, all derived from the rocks underlying the farms from which they harvest their crops.

Table I contains a summary of the mineral production for 1910, and in addition gives the number of employees engaged in mining or making the several products, and the sums paid them as wages. It should be borne in mind, in using these figures, that they have reference to the mines and plants actually engaged in the work of production, and do not include labor and wages expended in casual or preliminary work.

Table I.—Mineral Production of Ontario, 1910

Product.	Quantity.	Value.	Employees.	Wages.
Metallic:		$		$
Gold .... ounces	3,619	68,198	319	257,411
Silver .... "	30,651,417	15,481,322	3,317	2,973,772
Cobalt .... tons	1,098	54,699		
Nickel .... "	19,110	4,005,961	2,210	1,723,365
Copper .... "	9,630	1,374,103		
Iron ore .... "	230,656	513,721	561	315,537
Pig iron .... "	447,351	6,975,418	2,120	1,484,233
Zinc ore .... "	576	5,760	23	7,400
	....	28,479,182	8,550	6,761,718
Less Ontario iron ore (113,284 tons) smelted into pig iron	....	317,504	....	....
Net metallic production	....	28,161,678	....	....
Non-metallic:				
Actinolite	32	320	....	....
Arsenic, refined .... tons	1,524	70,709	....	....
" crude .... "	3,373	....	....	....
Brick, common .... No.	304,988,000	2,374,287	3,262	1,234,855
Tile, drain .... "	21,028,000	318,156		
Brick, pressed .... "	14,201,295	458,596	297	188,896
" paving .... "	3,799,0[illegible]5	70,648		
Building and crushed stone	....	761,126	876	364,914
Calcium carbide .... tons	3,072	184,323	56	37,630
Cement, Portland .... bbl.	2,471,837	3,111,313	1,233	713,550
Corundum .... Tons	1,870	171,991	201	100,945
Feldspar .... "	16,371	17,518	107	3[illegible],901
Fluorspar .... "	2	15	5	327
Graphite .... "	992	55,637	70	40,687
Gypsum .... "	10,043	17,825	52	5,062
Iron pyrites .... "	33,812	98,353	227	117,191
Lime .... bush.	2,889,235	471,531	100	177,975
Mica .... tons	513	85,294	128	47,162
Natural gas	....	1,191,239	186	118,785
Peat .... tons	851	1,284	29	3,500
Petroleum .... Imp. gal.	11,001,357	368,153	428	280,485
Pottery	....	51,185	40	16,878
Quartz .... tons	90,685	87,424	92	49,382
Salt .... "	84,071	114,978	202	114,056
Sewer pipe	....	357,087	210	110,106
Talc .... tons	5,821	46,592	37	15,252
	....	11,152,217	8,138	3,770,539
Add metallic production	....	28,161,678	8,550	6,761,718
Total production	....	39,313,895	16,688	10,532,257

The increase or decrease in the output of the several products is shown in Table II. which follows, the comparison being between the years 1910 and 1909:—

Table II.——Comparative Value Mineral Production, 1909 and 1910

Product.	1909.	1910.	Change. (I) Increase. (D) Decrease.	
Metallic:	$	$		$
Gold	32,445	68,498	I	36,053
Silver	12,464,722	15,481,322	I	3,016,600
Cobalt	91,965	51,699	D	40,266
Nickel	2,790,798	4,005,961	I	1,215,163
Copper	1,127,015	1,374,103	I	247,088
Iron ore	645,622	513,721	D	131,901
Pig iron	6,301,528	6,975,418	I	673,890
Zinc ore	8,950	5,760	D	3,190
Non-metallic:				
Actinolite	....	320	I	320
Arsenic	61,039	70,709	I	9,0
Brick, common	1,916,147	2,374,287	I	458,140
" pressed	490,571	458,596	D	31,975
" paving	73,700	70,648	D	3,052
Building and crushed stone	660,000	761,126	I	101,126
Calcium carbide	151,676	184,323	I	32,647
Cement, Portland	2,897,348	3,114,343	I	216,995
Corundum	140,817	171,994	I	31,177
Feldspar	36,204	47,518	I	11,314
Fluorspar	....	15	I	15
Graphite	37,624	55,637	I	18,013
Gypsum	23,604	17,825	D	5,779
Iron pyrites	78,170	98,353	I	20,183
Lime	170,858	474,531	I	3,673
Mica	73,121	85,291	I	12,170
Natural gas	1,188,179	1,491,239	I	303,060
Peat	240	1,284	I	1,044
Phosphate of lime	1,904	....	D	1,904
Petroleum	559,478	368,153	D	191,325
Pottery	43,214	51,185	I	8,271
Quartz	75,329	87,424	I	12,095
Salt	389,573	414,978	I	25,405
Sewer pipe	311,830	357,087	I	45,257
Talc	8,700	46,592	I	37,892
Tile, drain	363,550	318,456	D	45,094

For several years past the figures of production given in these Reports have been re-cast on the basis adopted by the Mines Department at Ottawa, in order to facilitate comparisons between the statistics presented by that Department and the Bureau respectively, and to enable the importance of this Province's mining industry to be more clearly seen. The difference between the methods of computation employed lies in the fact that while the several products are by the Bureau valued at their selling price at point of production, the Mines Department uses the price at which the refined article sells in the ruling market. This difference is confined to the metallic substances, the non-metallic products being valued by both at the place and in the form produced. For instance, the copper mined in Ontario, which comes mostly from the nickel-copper ores of the Sudbury district, is represented in the Bureau's tables at the value placed upon it by the mining companies themselves as a component of the Bessemer matte turned out by their converters, this being the highest stage of refinement attained in the Province. On the other hand, the Mines Department assumes the copper in the matte to be worth the price of refined metallic copper in New York, and values the output in its statistics accordingly. It is obvious that such a method will impute a much greater value to unrefined or partly refined substances than the one employed by the Bureau, and it is to meet the situation thus created that the Bureau's figures require to be presented in the alternative form. It should also be noted that in dealing with pig iron, the Mines Department includes only that made from Canadian ores, thus taking no account of the product of imported ore, from which is made the bulk of the pig iron produced in Canada.

Treating the figures of production for 1910, as per Table I. according to the methods of the Department of Mines, the following results are obtained:—

Table III.—Value Mineral Production, 1910, "Mines Department" Basis

Product.		Quantity.	Price.	Value.
Gold	oz.	3,619	\$18.94 per oz.	\$ 68,498
Silver	"	30,651,417	53.486 cents per oz.	16,394,217
Cobalt	tons	379 (a)	\$141.32 per ton	54,699
Nickel	"	18,636 (b)	30 cents per lb.	11,181,600
Copper	"	9,630	12.738 cents per lb.	2,453,330
Pig iron	"	77,961 (c)	\$15.50 per ton	1,204,210
Iron ore	"	80,354 (d)	\$2.23 per ton	179,189
Zinc ore	"	576	\$10.00 per ton	5,760
			Total	31,541,512
Value non-metallic production per Table I.				11,152,217
Gross value production				\$42,693,729

(a) Cobalt ore only paid for by smelters. (b) Contents Sudbury mattes only.
(c) Proportion pig iron from Ontario ore. (d) Exports only.

Taking the mineral production of the Dominion of Canada as given by the Department of Mines in its Preliminary Report for 1910 at \$105,040,958, the output of Ontario is thus shown to have been nearly 41 per cent. of the whole, or the same proportion as for the preceding year, 1909. In metals only, the increased yield of silver and nickel have of late years placed Ontario in the position of producing more than all the other Provinces put together. Last year her mines provided over 64 per cent. of the total metalliferous production of Canada.

The following table shows the progress, or the reverse, made in the various branches of the mining industry during the five years beginning with 1906:—

Table IV.—Mineral Production, 1906 to 1910

Product.	1906.	1907.	1908.	1909.	1910.
Metallic:	\$	\$	\$	\$	\$
Gold	66,193	66,399	60,337	32,445	68,498
Silver	3,689,286	6,157,871	9,136,830	12,464,722	15,481,322
Platinum.. / Palladium.	5,652	....	....	....	....
Cobalt	80,704	92,751	111,118	94,965	54,699
Copper	960,813	1,045,511	1,071,110	1,127,015	1,374,103
Nickel	3,839,419	2,271,616	1,866,059	2,790,798	4,005,961
Iron ore	301,032	482,532	574,839	645,622	513,721
Pig iron	4,554,247	4,716,857	4,390,839	6,301,528	6,975,418
Pig lead	93,500	....	....	....	....
Zinc ore	6,000	....	....	8,950	5,760
	13,596,846	14,833,537	17,211,162	23,466,045	28,479,482
Less value Ontario iron ore smelted into pig iron	243,776	282,702	456,176	537,549	317,804
Net metallic production	13,353,080	14,550,835	16,754,986	22,928,496	28,161,678
Non-metallic:					
Actinolite	....	....	....	....	320
Arsenic	15,858	40,104	40,373	61,039	70,709
Brick, common	2,157,000	2,109,978	1,575,875	1,916,147	2,374,287
" paving	45,000	73,270	61,554	73,700	70,648
" pressed	337,795	648,683	485,819	490,571	458,596
Building and crushed stone	660,000	675,000	530,041	660,000	761,126
Carbide of calcium	162,780	173,763	147,150	151,676	184,323
Cement, natural rock	6,000	5,097	....	....	....
" Portland	2,381,014	2,777,478	2,417,769	2,897,348	3,144,343
Corundum	262,418	242,608	11,437	140,817	171,994
Feldspar	13,849	30,375	20,300	36,204	47,518
Fluorspar	....	....	....	....	15
Graphite	15,000	20,000	1,600	37,624	55,637
Gypsum	6,605	19,652	20,778	23,601	17,825
Iron pyrites	10,583	51,842	69,980	78,170	98,353
Lime	496,785	418,700	118,596	470,858	474,531
Mica	69,041	82,929	73,586	73,124	85,294
Natural gas	533,146	746,499	988,616	1,188,179	1,491,239
Peat fuel	900	1,040	900	240	1,284
Petroleum, crude	761,546	1,049,631	703,773	559,478	368,153
Phosphate of lime	....	....	7,048	1,904	....
Pottery	65,000	54,585	50,310	43,211	51,485
Quartz	65,765	121,118	52,830	75,329	87,424
Salt	367,738	132,936	488,330	389,573	414,978
Sewer pipe	279,620	135,088	344,260	311,830	357,087
Sodalite	6,000	....	....	....	....
Talc	3,030	5,010	3,048	8,700	46,592
Tile, drain	252,500	250,122	338,658	363,550	318,456
Total non-metallic	9,035,303	10,168,538	8,882,631	10,052,879	11,152,217
Add metallic production	13,353,080	14,550,835	16,754,986	22,928,496	28,161,678
Total production	22,388,383	25,019,373	25,637,617	32,981,375	39,313,895

The quantity and value of the entire mineral production of Ontario from the beginning cannot now with exactness be ascertained, since the mining industry had been long in existence before any systematic collection of yearly statistics was begun. The time to procure and put on record statistical data of any kind is when the data are in the making, or immediately afterwards. If not attempted until subsequently the results are usually uncertain in proportion to the lapse of time and the scarcity of contemporary evidence. An effort was made in the Nineteenth Report[1] to present figures showing the entire output of metals and metallic ores since the opening of mines in Ontario, and on the basis of the Table there given the production is now brought down to the end of 1910. The total value as shown amounts to over one hundred and sixty-one millions of dollars, or allowing for some over-lapping due to including the figures for iron ore as well as pig iron, say one hundred and fifty-seven or one hundred and fifty-eight millions, according to the Bureau's method of valuation. If computed on the basis of refined prices, the aggregate would considerably exceed two hundred millions of dollars.

Table V.—Total Production of Metals in Ontario

Product.		Quantity.	Value.
			$
Gold	oz.	163,336	2,577,990
Silver	"	98,872,911	63,550,176
Platinum and Palladium	"	3,364	62,781
Cobalt	tons	5,215	585,470
Nickel	"	118,673	32,611,829
Copper	"	99,098	14,374,103
Iron ore	"	3,180,656	6,039,571
Pig iron	"	2 656,105	41,475,418
Lead ore	"	3,351	20,000
Pig lead	"	1,113	96,000
Zinc ore	"	7,704	92,410
Total			161,486,051

Gold

There were nine properties from which gold bullion was recovered in 1910, the output being 3,619 ounces, valued at $68,498. This is an improvement over 1909, when the yield was 2,042 ounces worth $32,445. The producing mines were the Gilmour, in Hastings county; Havilah, formerly the Ophir, in Galbraith township, north shore of lake Huron; Canadian Exploration Company's at Long lake on the Sault branch of the C.P.R; Mikado, on Shoal lake, Lake of the Woods; Le Page and Norwalk, Michipicoten; Swastika in Otto township, T. & N. O. railway; and Hollinger and Dome, Porcupine. The Porcupine mines were responsible for more than one-half the production, small stamping outfits having been installed to treat the ore taken out during development work; better than one-quarter came from the Canadian Exploration Company's mine near Long lake, on which a deposit of arsenical ore is being opened up with promise of good results, and in a hitherto unworked field. The remainder came in scattered quantities from the other properties mentioned. One of these, namely, the Mikado, a number of years ago shared with the Sultana the leadership of the productive mines on Lake of the Woods, and is again being worked by a new company under the directions of Capt. H. A. Machin, M.P.P. During the former operations the Mikado is credited with having produced over $500,000 in gold. The Ophir or Havilah mine was opened up in 1892, the surface showings being very good. After being worked spasmodically for a number of years, it was closed down in 1902. Both the Mikado and Ophir are described in Reports of the Bureau of Mines. For the former, see volumes 6 to 13: battery statistics for 1896, 1897 and 1898 are given in vol. 8, page 22. For the Ophir particulars may be found in volumes 2 and 3.

[1] 19th Rep. B.M., 1910, pt. I., p. 9.

Interest in gold mining at present centres in the Porcupine camp. The spectacular showings of free gold found here in 1909 on the Dome, Hollinger, Bannerman, and other claims, speedily attracted a rush of prospectors, who have been and still are engaged in locating veins and staking claims. It was fortunate for the early development of the camp that the pioneer work fell largely to the lot of two groups of men of undoubted financial strength, both possessing much experience in the proving of mining properties in Ontario. One of these was composed of Messrs. L. H. and N. A. Timmins, John A. and Duncan McMartin and D. A. Dunlap, who were associated with La Rose silver mine, one of the first discovered and most famous mines of Cobalt. These men took over the Hollinger claims and have been steadily developing them since the summer of 1909 with much judgment and success. The Canadian Copper Company and allied interests furnished the second group, under whose management the Dome mines are being rapidly brought to the point of producing bullion. At the present time a 30-stamp mill is being installed at the Hollinger and a 40-stamp mill at the Dome. Water power for use at Porcupine is being developed at two points on the Mattagami river, one downstream at Sandy Falls in the township of Mountjoy, about six miles distant, by Messrs. A. M. Bilsky and H. D. Symmes; and one at Wawaitin Falls, about sixteen miles up the river, by E. A. Wallberg.

A report on the Porcupine gold field by Mr. A. G. Burrows, Assistant Provincial Geologist, accompanied by a revised and extended geological map with full annotations, is published as Part II. of this Report, and should be referred to for a description of the geology and mineralogy of the district.

The gold discoveries in the township of Munro and neighborhood, lying east of the T. & N. O. railway, have been undergoing development, and considerable machinery was placed upon some of them during the winter of 1910-11. At the Swastika mine, Otto township, work seems to have proven the existence of gold at some depth. Gold is also reported from the vicinity of Hobon, where the Algoma Central and Hudson Bay railway will join the main line of the C. P. R., but there is as yet little information concerning the occurrence here or the nature of the rock formations. The interest evoked by the Porcupine finds has extended to some of the older fields, including that of Hastings county, where the old Belmont or Cordova mine has passed into the control of Mr. P. Kirkegaard, long connected with the mining and treatment of the auriferous mispickel deposits at Deloro in the same county. It is proposed by Mr. Kirkegaard to re-open the mine, on which there is a fully-equipped 30-stamp mill ready for operation.

There was no production from Sturgeon lake. Dr. E. S. Moore completed his survey of this district last year, and his report thereon is published in this volume under the title "The Sturgeon Lake Gold Field."

Silver

The yield of the silver mines of the Province in 1910 was 30,651,417 fine ounces, the money return from which to the mining companies was $15,481,322. As compared with 1909, the output was 4,747,432 ounces, and the value $3,016,600, greater. Practically the whole of the production was from the mines of Cobalt, including in that term South Lorrain, Elk Lake and Gowganda.

The mines of Cobalt camp from the beginning up to 31st December, 1910, have added upwards of 94 million ounces to the world's stock of silver. The number of the producing mines was 39, of which 38 were at Cobalt, the remaining one being the Hanson Consolidated, the only mine in the Port Arthur silver region which returned any production last year.

The full list of the productive mines is as follows, and after the names of most is given the output for the year 1910. This is a departure from the practice hitherto followed by the Bureau in refraining from publishing the production of individual properties, and is made with the consent of the companies in question. In any event,

in the case of most mines, the figures of production are annually put in print for the information of the shareholders, so that such statistics are easily available to any one interested, and there now seems, especially in such a well-established camp as Cobalt, no good reason for withholding the figures. The list is as follows:

Mine.	Production, 1910. Oz.
Nipissing	5,590,080
La Rose (including Lawson)	3,484,754
Crown Reserve (including Silver Leaf)	3,255,567
Kerr Lake	2,877,299
Coniagas	2,621,681
McKinley-Darragh-Savage	2,606,891
Temiskaming	1,994,226
Buffalo	1,629,328
Hudson Bay	985,552
Trethewey	846,579
Right of Way	455,986
Millerett	322,006
City of Cobalt	305,216
Wettlaufer-Lorrain	199,920
Cobalt Town Site	195,597
Beaver	181,450

Other producers were O'Brien, Nova Scotia, Little Nipissing, Silver Cliff, Cobalt Lake, Chambers-Ferland, Hargrave, Colonial, Drummond, King Edward, Wyandoh, Rochester, Provincial, Waldman, Boyd-Gordon, Dobie-Reeve, Miller Lake-O'Brien, Bonsall, Lucky Godfrey, Bellellen and Casey Cobalt.

From two mines in South Lorrain, the Bellellen and Wettlaufer-Lorrain, there were shipped 233 tons of ore containing 221,233 ounces of silver, and from six in Gowganda and Elk Lake, namely, Boyd-Gordon, Dobie-Reeve, Miller Lake-O'Brien, Millerett, Bonsall and Lucky Godfrey, 480 tons, containing 481,523 ounces. The remainder was from Cobalt proper, excepting small returns from Casey Cobalt, which geographically is quite outside the recognized Cobalt area, and Hanson Consolidated, situated west of Port Arthur.

There were shipped from the mines 27,485 tons of ore and 6,874 tons of concentrates; also 980,633 ounces of bullion obtained partly by cyanidation and partly by the smelting of nuggets and metallic silver. The ore shipped contained an average of 821 ounces of silver per ton, and the concentrates 1,030 ounces; or taken together, ore and con-concentrates carried 863.5 ounces per ton. In 1909 the corresponding figures were: ore, 809 ounces, concentrates 1,165 ounces, per ton; or together 842.6 ounces per ton. Notwithstanding the fact that a very considerable quantity of low-grade silicious ore was shipped to such smelting points as Denver, Colorado, where it is utilized in mixing with ores of a more basic character, the general quality of the material shipped by the mines of Cobalt, as indicated by these figures, shows no symptoms of a lowering in quality. If the metallics melted down to form a part of the bullion sent out by the mines had been included in the ore, they would have still further heightened its grade.

Concentrating Low Grade Ores.

In the natural development of Cobalt the concentration of low-grade ores is yearly assuming greater importance. The first concentrates were made in 1908, amounting to 1,137 tons; in 1909 the shipments were 2,948 tons, and in 1910 they rose to 6,846 tons. Although constituting by weight only 20 per cent. of the shipments from the camp in 1910, they accounted for 23.1 per cent. of the total yield of silver. There were at work

during the year fourteen concentration plants, of which three were customs mills, namely, Northern Customs Concentrators, Nipissing Reduction Works and Montreal Reduction Company's plant at Trout Mills; and the remaining eleven were operated by as many mining companies for the treatment of their ores. A fourteenth plant, that of the Hudson Bay Mines, Limited, was under construction at the close of the year, and has since begun work.

Following is a list of the concentration plants, showing also their capacity in tons of ore per day:

Mine.	Capacity.
Buffalo	120
Colonial	30
Coniagas	175
Hudson Bay	75
King Edward	30
McKinley-Darragh-Savage	90
Nova Scotia	75
O'Brien	90
Silver Cliff	75
Standard Cobalt	75
Temiskaming	90
Trethewey	85
Custom mills:—	
Nipissing Reduction Company	40
Northern Customs Concentrators	175
Montreal Reduction Works (closed).	
Total	1,225

The actual concentration of ore throughout the year is shown in the subjoined table. The ore is credited to the mine producing it, as well when the concentration was performed at a custom plant as when at a mill owned and operated by the company itself. A few companies have expressed a wish that the details of their business should not be published except in bulk, and their wishes are respected.

Table VI.—Concentration of Silver Ore, 1910.

Name of Mine.	Ore Concentrated. Tons.	Concentrates produced. Tons.	Silver in concentrates. Ounces.	Average silver in concentrates per ton. Ounces.	Ratio of concentration.
Buffalo	39,038	969	1,151,470	1,203	40 to 1
City of Cobalt	9,367	211	201,802	913	43 " 1
Coniagas	38,709	907.1	1,318,836	1,486	42 " 1
King Edward	8,805	152.7	87,519	573	62 " 1
La Rose	32,303	809.5	585,152	783	40 " 1
McKinley-Darragh	43,279	1,922.3	1,615,168	849	22 " 1
Nipissing	13,981	328.6	381,155	1,017	42 " 1
O'Brien	25,687	211.5	351,889	1,170	....
Temiskaming	21,683	653.1	529,099	811	33 " 1
Trethewey	19,013	236.5	400,391	1,729	80 " 1
Standard Cobalt	22,426	310.	111,458	473	74 " 1
Various other mines	31,275	300	347,171	1,058	104 " 1
Totals	305,569	7,014.3	7,084,710	Av., 1,030	Av., 43.5 to 1

The shipments of concentrates were slightly less than the production, being 6,874.6 tons as against 7,014.3, and the average silver contents per ton are, of course, based on the shipments. It will be observed that there is a wide variation, not only in the silver tenor of the concentrates, but also in the ratio of concentration. The former ranges from 473 ounces for the Standard Cobalt to 1,729 ounces for the Trethewey. In general,

it would seem that the mines situated on the conglomerate carry richer milling rock than those whose veins occur in the diabase. The little stringers or veinlets found leading into and sometimes connecting the smaltite veins in conglomerate areas as a rule partake of the nature of the parent leads and contain silver as well as cobalt, nickel and arsenic, in similar proportions. In the diabase the wall rock may be sufficiently rich to warrant its being put through the concentrator, but the silver is present chiefly in leaf form or as infiltrations, unassociated with any considerable percentages of the other minerals, and, as it would appear, generally in smaller amount than in the conglomerate.

Assuming that on an average 85 per cent. of the silver is recovered in the concentrates, the average contents of the rock milled last year were 27.2 ounces per ton. The dividing line between shipping ore and mill rock is probably about 100 ounces per ton, and as the cost of treatment is about $3.50 per ton, ore containing less than 10 ounces per ton is considered unprofitable.

Market for Ores

There is a good demand for the silver ores of Cobalt, for the higher grades as well as for the poorer, more silicious qualities which have a value for fluxing purposes apart from their silver contents. Part of the richer ore goes to smelters in New York, Pennsylvania and New Jersey, and some of the heavy metallic ore from such mines as the Crown Reserve finds its way to the works of Beer, Sondheimer and Company in Germany, but most of the high grade ore is now refined in Ontario by the Canadian Copper Company, Copper Cliff, the Deloro Mining and Reduction Company, Deloro, and the Coniagas Reduction Company, whose head office is at St. Catharines and works at Thorold. These three companies combined treated 9,466 tons of ore and concentrates in 1910, the recovery of silver from which amounted to 14,574,837 fine ounces. The remainder of the output, consisting of 24,893 tons of ore and concentrates, yielding 16,076,580 ounces of silver, was exported, mainly to the United States. The material sent abroad for treatment thus contained on an average 645 ounces per ton, while that refined at home carried an average of 1,539 ounces per ton.

In addition to the three Canadian companies mentioned, the following concerns were in the market last year for Cobalt silver ores: American Smelting and Refining Company, whose purchases of low-grade ore were sent to Denver, Col., and Omaha, Neb., and of high grade to Perth Amboy, N. J., Balbach Smelting and Refining Company, Newark, N. J., Pennsylvania Smelting Company, Carnegie, Pa., United States Metals Refining Company, Chrome, N. J., Beer, Sondheimer and Company, Frankfort-on-Main, Germany, and Quick, Barton and Company, London, England. The tariffs according to which these companies buy the ores vary a good deal in details, some imposing a refining charge of a half or three-quarters of a cent per ounce of silver, and a treatment charge of $10 or $25 per ton of ore, and paying for 95 up to 98 per cent. of the silver contents; others omitting the treatment charges, but paying for up to 95 per cent. of the silver, and subjecting nickel and arsenic to certain penalties if in excess of specified proportions. Neither cobalt, nickel nor arsenic are now paid for by ore-buyers.

Three new companies have erected plants for treating cobalt silver ores in Ontario, and expect to be in the market for the purchase of ores. These are Dominion Metals, Limited, Toronto, Canada Refining and Smelting Company, Orillia, and Swansea Smelting and Refining Company, Swansea.

The facilities for handling ore in the Cobalt camp were increased in 1910 by the establishment of a sampling plant by Messrs. Campbell and Deyell. The works have a capacity of 30 tons of high grade ore per day, and are proving of much convenience to the mines. Without the aid of a sampling plant, it is a difficult matter to estimate closely the contents or value of a carload of such irregular material as high grade silver ore from Cobalt, but by ascertaining the contents in advance of sale or shipment, the seller is enabled to choose the market for which his ore is best suited. The advant-

ages will be still more apparent when the sampling and assay come to be accepted as authoritative by smelters and buyers generally.

The operations of the Canadian cobalt-silver smelting works for the year 1910 may be summarized as follows:—

Ore received	9,506 tons
Ore treated	9,466 tons
White arsenic recovered and shipped	3,047,699 pounds
Value of ditto	$70,709
Cobalt oxide shipped	13,508 pounds
Value of ditto	$9,630
Mixed oxides of Cobalt and nickel shipped..............	108,178 pounds
Value of ditto	$18,769
Silver recovered	14,574,837 ounces
Value of ditto	$7,656,098
Workmen employed	298
Wages paid	$212,694

From the time the mines of Cobalt were opened in 1904 down to 31st December, 1910, the production of silver has been as shown in the following table:—

Table VII.—Silver Production, Cobalt Mines, 1904 to 1910

Year.	Producing Mines.	Shipments.			Silver Contents.			Ave'ge Silver Contents per Ton.		Value of Silver Shipments.			Total Value.
		Ore.	Concentrates	Bullion.	Ore.	Concentrates.	Bullion.	Ore.	Concentrates.	Ore.	Concentrates.	Bullion.	
	No.	Tons.	Tons.	oz.	oz.	oz.	oz.	oz.	oz.	$	$	$	$
1904	4	158	....	....	206,875	....	....	1,309	....	111,887	....	....	111,887
1905	16	2,111	....	....	2,151,356	....	....	1,113	....	1,360,503	....	....	1,360,503
1906	17	5,335	....	....	5,401,766	....	....	1,013	....	3,667,551	....	....	3,667,551
1907	28	11,788	....	....	10,023,311	....	....	677	....	6,155,391	....	....	6,155,391
1908	30	21,187	1,137	....	18,022,480	1,115,395	....	736	1,241	8,468,293	665,085	....	9,133,378
1909	31	27,729	2,948	....	22,436,355	3,161,470	....	809	1,174	10,809,872	1,651,704	....	12,461,576
1910	41	27,437	6,845	980,633	22,581,714	7,082,831	980,633	821	1,030	11,360,189	3,590,098	527,460	15,478,047
Tl.	..	[illegible]	10,930	980,633	81,123,857	11,359,699	980,633	795	1,094	41,933,986	5,906,887	527,460	48,368,333

The record is one of steady and rapid progress, not easily matched in the annals of the mining industry in any part of the world. Cobalt has given Ontario third place among silver producing countries, coming next after Mexico and the United States. The estimated production of the world in 1910 as given by the Director of the United States Mint was 217,788,711 ounces, Mexico being credited with 72,574.220 ounces, and the United States with 56,438,695 ounces. The production of Canada is given in the Director's table as 32,878,510 ounces, which is a close approximation to the actual figures, Ontario's output being 30,651,417 ounces, per Table I., and British Columbia's 2,500,000 ounces as stated by Mr. Wm. Fleet Robertson, Provincial Mineralogist of that Province in his preliminary estimate of mineral production for 1910, issued in January, 1911. South America, whose silver mines once united with the golden ingots of the Incas to fire the imagination and arouse the cupidity of her Spanish conquerors, yielded in 1910 only 16,176,228 ounces, while Australasia furnished about the same quantity, or 16,359,281 ounces. That is to say, Ontario's silver product last year was almost as great as that of South America and Australasia combined. It may not be out of place to show the sources at present supplying the world's requirements of silver, which is being poured forth from her mines at a rate never equalled before. The figures are those put out by the United States Mint.

Silver Production of the World

Country.	Production in 1910. Fine ounces.		Proportion of whole output. Per cent.
Mexico	72,574,220		33.3
United States	56,138,695		25.9
Canada	32,878,590		15.1
South America	16,176,928		7.6
Central do	2,291,272		1.0
Total America		180,662,705	82.9
Germany	5,332,901		....
Spain	4,767,091		....
Austria-Hungary	999,181		....
Greece	829,025		....
Italy	786,620		....
France	673,302		....
Great Britain	618,429		....
Russia	158,546		....
Norway	213,122		....
Sweden	29,373		....
Servia	10,230		....
Turkey	7,971		....
Total Europe		14,425,791	6.6
Australasia		16,359,281	7.6
Japan	4,798,351		....
Dutch East Indies	465,980		....
Total Asia		5,264,331	2.4
Africa		1,076,600	0.5
Total		217,788,714	100.0

These figures show that the world depends upon America for silver. This continent, including both North and South America, furnishes 82.9 per cent of the whole, Australasia 7.6 per cent., Europe 6.6 per cent., Asia 2.4 per cent., and Africa 0.5 per cent. In gold the position is quite different. The mines of the Rand give the dark continent first place in the list, her total of $175,000,000 for 1910 being more than the yield of the United States and Australasia combined, though less than the united output of the whole of America and Australasia.

It is at first sight remarkable that notwithstanding the great reduction in the price of silver per ounce as compared with 40, 30, or even 20 years ago, production goes on at a constantly accelerated rate. Thus in 1871 the world's product was 63,317,014 ounces, in 1881, 79,020,872 ounces, in 1891, 137,170,919 ounces, in 1901, 173,011,283 ounces, and in 1911 217,788,714 ounces. In 40 years the annual output has increased nearly 3½ times, and this in face of the fact that in 1871 the price was $1.326 per ounce, in 1881, $1.138 per ounce, in 1891, $0.988 per ounce, in 1901, $0.589 per ounce, and in 1910, $0.534 per ounce. The explanation doubtless is that to a very considerable extent silver is now in reality a bye-product, being a constituent of ores which are raised for the sake of other metals. For instance, in the mining of gold, copper, lead and mixed ores of other kinds, a proportion of silver is present, and is recovered in the process of treatment. The mines of Cobalt are not of this class, silver being practically the only element of value. The unceasing demand for gold would of itself necessitate the production of a very considerable quantity of silver, and copper and lead being prime requisites in the arts and industries of civilization, the flood of silver is likely to continue, even at the existing low level of values, since the market price is not the predominant factor in determining the supply. The richness of the ores of Cobalt, however, is such as to enable the mines to be worked to great advantage at the present time, and many of them would continue to produce were silver half its present price, though of course profits would suffer very materially.

Prices and Markets for Silver

The average price of silver in 1910 per fine ounce in the New York market was 53.486 cents, being nearly 2 cents higher than last year. The market opened in January at 52.375 cents and dropped in March to the lowest point in the year, namely, 51.454 cents, recovered in April to 53.221 cents, went up to 54.150 cents in July, fell to 52.912 cents in August, touched the highest figure for the year, 55.635 cents, in November, and closed in December at 54.428 cents. The fall in March is attributed to the action of the government of India in raising the import duty on silver, from 5 per cent. *ad valorem* to fourpence per ounce, the change coming into force 25th February. The controlling influence on the price of silver is the demand in Eastern Asia, particularly in India and China. In fact, it may be said that the bazaars of India determine the value. If rains are abundant and crops good, the peasants of India make a brisk market for silver, in which metal they have from time immemorial been accustomed to invest their savings, chiefly in the form of ornaments. If times are bad they cease to buy, or buy less largely; and when famine presses they are forced to part with some of their reserves. The drainage of the world's silver system leads to India, and year by year vast quantities are absorbed by the people of that country, which are never again brought to market. China, too, for the purposes of her unwieldy currency system, if system it can be called, requires considerable quantities of silver, and was an important buyer in 1910. Indian and Chinese speculators, however, are as prompt to take advantage of a turn in the market as are those of London or New York, and transactions between bulls and bears in the East do not always imply actual deliveries any more than they do in the West. The world's mart, or rather clearing house, for silver is London, whence about $35,000,000 worth was exported to India in 1910 and $7,500,000 to China. About $7,500,000 additional was sent to China direct from San Francisco. The bullion produced at Cobalt and the several refining works in Ontario goes to London.

At the close of 1910 the prospects were for a good demand and consequently sustained or even better prices for silver. Crops were good in India, except cotton, also in China, where a new and important item of agricultural produce in the shape of Soya beans has begun to figure largely in the exports. The Chinese government has resolved upon the introduction of a uniform system of silver currency to replace the present chaotic condition caused by the local variations in the weight and value of the tael, and proposes to borrow some £10,000,000 for the purposes of this necessary reform. It is thought that the new scheme will have a beneficial effect upon the price of silver. The use of silver in the arts is increasing, and apart from household ware and decorative purposes, an appreciable quantity is required in preparing sensitive plates in photography, and when so used, unlike tableware and ornaments, the silver is not recoverable and disappears entirely. The governments of India, Germany, Russia and some other countries are likely to be purchasers of silver for coinage purposes in 1911, and altogether the outlook is for fair prices in the immediate future, though the day of $1.20 or $1.30 per ounce for silver is not likely to return. On the basis of last year's production the rise or fall of one cent per ounce in the price of silver makes a difference of over $300,000 to the mine-owners of Cobalt.

Labor and Health

The operating silver mines employed 3,020 men, but this number does not include miners and laborers engaged in prospecting or assessment work on mining claims, or in testing properties not brought to the productive stage. There was paid out to these men in wages the sum of $2,761,078. On the average the mines were in operation almost 300 days during the year, or practically full time, hence the average rate of wages per employee works out at about $3.00 per day. Skilled miners and machinemen, etc., command higher figures, but muckers and laborers get less. The supply of labor was ample in the mines of Cobalt, and there were no disturbances of any kind during the year.

The silver refineries gave employment to 298 men who received in wages $212,694.

The health of the Cobalt camp was good, and there was no recurrence of the typhoid epidemic which scourged the district in 1909.

Cobalt, Nickel and Arsenic

In the table given below (page 18) are presented statistics of the total production of the mines of Cobalt, including cobalt, nickel and arsenic as well as silver. Owing to the fact that nickel and arsenic have ceased to bring any return to the producers, and cobalt last year only when in excess of six per cent., few or no assays are made of these constituents, and it is impossible to do more than estimate the actual output. Though not paid for, nickel and arsenic are not wholly or even largely lost, and it may be taken for granted that a large proportion of both, as well as of cobalt, ultimately find their way into use in the arts. The arsenic is recovered at all three of the Canadian refineries now in operation, and the new ones are also designed to save it. Where the percentage is small, as in some of the low grade ores, doubtless it goes to waste. The same is true of nickel, but where the cobalt is present in sufficient quantity to warrant its recovery, the nickel is obtained at the same time.

Some pains have been taken to determine, if possible, the actual production of cobalt, nickel and arsenic from the mines of Cobalt, but it cannot be claimed that absolutely certain results have been reached. Probably, however, the figures are not far from the truth. The difficulty in obtaining precise information lies in the fact that the mining companies receive nothing for the nickel and arsenic contents of their ores, and only on rare occasions anything for the cobalt. In consequence they have no incentive to ascertain with anything like accuracy the quantities of these elements contained in their shipments, and make few or no assays for the purpose. From the smelting companies at Copper Cliff, Deloro and Thorold, however, have been obtained statistics covering their entire operations up to the end of 1910, giving the quantity of ore treated, and the contents of the same not only in silver, but also in cobalt, nickel and arsenic. These show that the three plants had put through a total of 28,013 tons of ore, practically all high grade, and concentrates, the contents of which were 49,709,321 ounces of silver, 1893.95 tons of cobalt, 1042.69 tons of nickel, and 8404.34 tons of arsenic. The proportions of the several constituents were: Silver, 6.084 per cent. (1774.5 ounces per ton); cobalt 6.76 per cent.; nickel, 3.72 per cent., and arsenic 30 per cent. That is to say, for every 1 per cent. of arsenic there were present .225 per cent. cobalt, and .124 per cent. nickel.

The facts are much less easy of ascertainment with regard to the ores exported, mainly to the United States, for treatment. It may be taken for granted that the high grade ore and concentrates exported will carry the same proportions of cobalt, nickel and arsenic as like material treated at home, but much of the exports were of low grade, and it is difficult to obtain definite information respecting the percentages present of the three subsidiary elements. The total quantity of ore and concentrates exported was 24,876 tons, containing 16,076,580 ounces of silver. The average silver contents were therefore 646.2 ounces per ton, as compared with 1,774.5 ounces per ton yielded by the material treated by the Canadian smelters.

It would be a short cut to a result to assume that the entire mineralization of the exported ore was on the same scale as for the silver alone, and that consequently the cobalt, nickel and arsenic contents per ton of the exported material would bear the same proportion to those of the ore treated at home as does the silver in the latter ores. The ratio would then be 646.2 to 1,774.5.

Arsenic the Governing Factor

It is obvious, however, that the real key to the situation is the arsenic, not the silver. The cobalt and nickel are both in chemical combination with the arsenic, while the silver is largely in the metallic form, or if in compounds, the combination is

chiefly with sulphur instead of with arsenic. Hence, the proportion of silver, though no doubt some indication of the proportion of the other substances, cannot be regarded as a definite guide. On the other hand, while it is true that the ores of Cobalt contain a variety of minerals carrying arsenic and cobalt and arsenic and nickel, differing from one another in the percentages of the respective elements, it is not a violent assumption that one year with another, and one mine with another, the proportion of arsenic to cobalt and to nickel will remain approximately uniform.

Data are not entirely wanting with regard to the arsenic contents of the low grade ores smelted in the United States. The United States Metals Refining Company of New York, whose works are at Chrome, N. J., smelted up to 31st December, 1910, 10,462 tons of Cobalt ore averaging 221.3 ounces of silver and 2.87 per cent. of arsenic. The American Smelting and Refining Company at their Denver, Col., works up to the same time smelted 28,097 tons containing an average of 184.3 ounces of silver and 4.19 per cent. of arsenic. Thus, these two companies found an average of 3.82 per cent. of arsenic in 38,559 tons of ore, whose silver contents averaged 194.4 ounces per ton. Assuming that the proportion between arsenic on the one hand, and cobalt and nickel on the other, was the same in these low grade ores as in the high grade material treated by the Ontario smelting companies, 3.82 per cent. of arsenic would imply the presence of .833 per cent. of cobalt, and .458 per cent. of nickel.

If, then, the arsenic contents of the entire production at Cobalt were known, we could arrive at a fairly close approximation of the cobalt and nickel output; but this factor in the problem is wanting. Say, however, that of the 27,437 tons of ore shipped out in 1910, in addition to the concentrates, one-fourth was high-grade, and three-fourths low-grade. This would give 6,859 tons of the former and 20,578 of the latter. Adding the concentrates, 6,845 tons, to the high-grade ore, we have 13,704 tons of material containing 6.76 per cent. cobalt, 3.72 per cent. nickel, and 30 per cent. arsenic; and 20,578 tons containing, as we have assumed, .833 per cent. cobalt, .458 per cent. nickel, and 3.7 per cent. arsenic. The yield of the several substances would, therefore, be:—

	Cobalt. Tons.	Nickel. Tons.	Arsenic. Tons.
High-grade ore, etc.	926.39	509.78	4,111.20
Low-grade ore, etc.	171.41	94.24	786.07
Total	1,097.80	604.02	4,897.27

or for the entire product of the mines for 1910, namely, 34,282 tons of ore and concentrates, an average of 3.20 per cent. cobalt, 1.47 per cent. nickel and 14.28 per cent. arsenic. For arsenic the figures are practically the same as were assumed in last year's Report, namely, 14 per cent., but are somewhat lower for cobalt and nickel, the assumed percentages being then 5 and 2½ per cent. respectively.

Table VIII.—Total Production, Cobalt Mines, 1904 to 1910.

Year.	Shipments ore and concentrates. Tons.	Nickel. Tons.	Nickel. Value.	Cobalt. Tons.	Cobalt. Value.	Arsenic. Tons.	Arsenic. Value.	Silver. Ounces.	Silver. Value.	Total Value.
			$		$		$		$	$
1904......	158	14	[illegible]	16	19,960	72	903	206,875	111,887	136,217
1905......	2,144	75	10,000	118	100,000	549	2,693	2,451,356	1,360,503	1,473,196
1906......	5,335	160	....	321	80,704	1,440	15,858	5,401,766	3,667,551	3,764,113
1907......	14,788	370	1,174	739	101,426	2,958	40,104	10,023,311	6,155,391	6,301,095
1908......	25,624	612	....	1,224	111,118	3,672	40,373	19,437,875	9,133,378	9,284,869
1909......	30,677	766	....	1,533	94,965	1,294	61,039	25,897,825	12,461,576	12,617,580
1910......	34,282	[illegible]	....	[illegible]	51,699	4,897	70,709	30,645,181	15,478,047	15,603,455
Total ..	[illegible]	[illegible]	14,611	[illegible]	565,872	17,891	231,679	94,461,189	48,368,333	49,180,525

Note. The production of 1910 includes 980,633 ounces bullion.

Dividends

The dividends paid or declared by silver mining companies at Cobalt during 1910, amounted to $7,275,239.90, and for the period ending 31st December, 1910, to $21,802,179.58. These sums do not include the very considerable profits made by private individuals or close corporations in the operation of their own properties, including the Drummond and O'Brien mines. If these sums were taken into the account, it would probably be found that the total dividends would be at least $25,000,000, or more than 50 per cent. of the gross receipts from the mines. A table of the dividend-paying companies is given on page 20, from which it will be seen that several have now returned to the shareholders dividends equalling the entire share capital, and others are rapidly approaching this point. A few companies, notably the Nipissing Mining Company, Limited, and Kerr Lake Mining Company, Limited, whose capital is given as $250,000 and $40,000 respectively are really only operating companies for larger organizations capitalized, the former at $6,000,000, and the latter at $3,000,000. In the case of the Nipissing, even the $6,000,000 and more has been paid back in dividends.

Last year the annual statements of four of the leading mines at Cobalt, namely, Nipissing, Crown Reserve, Kerr Lake and Coniagas, were summarized with the view of affording a nearer view of the operations and financial results of these splendid properties. Similar data for the succeeding year is given below, and La Rose and McKinley-Darragh-Savage mines are also included in the list.

Nipissing

The income from ore sold during the year and value of ore at mine in transit and at smelters, 31st December, 1910, was $2,984,084.19, other income from ground rents, etc., $52,668.85, total $3,036,753.04. Cost of mining and all other expenses amounted to $869,649.54, leaving a profit on the year's production of $2,167,103.50, in addition to surplus at 1st January of $913,195.46. After paying dividends in 1910 amounting to $1,672,500 and providing for January, 1911, dividend, $455,000, the net surplus carried forward was $952,798.96. Shipments were as follows:—

Material.	Dry Tons.	Net Value per Ton. $	Gross ounces Silver.	Net Value. $	Per cent. of Total Value.
High Grade Ore............	1531.792	1,317.51	3,999,580.48	2,018,152.21	73.6
Low Grade Silicious Ore...	4834.3315	88.34	1,008,357.79	427,069.68	15.6
Concentrates	319.12	156.90	296,490.55	145,805.27	5.3
Nuggets	13.6865	11,051.25	293,349.79	151,294.07	5.5
Total................	6698.93	(*av.*) 409.37	5,597,778.61	2,742,321.23	100.0

The average assay of the shipments was: High grade ore 2,611.04 ounces silver, 9.35 per cent. cobalt and 6.72 per cent. nickel per ton; low grade silicious ore 208.58 ounces silver; concentrates 929.08 ounces silver, 6.46 per cent. cobalt and 2.68 per cent. nickel; nuggets 21,433.51 ounces silver per ton. Based on a production of 6,717.26 tons ore and concentrates, containing 5,518,651.91 ounces silver, the cost of production worked out at $0.1472 per ounce, as per the following table:—

		Per ounce silver.
Mine operation	$492,224 05	$0.0887
Concentration	45,872 95	0.0083
Depreciation	32,325 22	0.0058
Marketing ore	279,169 61	0.0503
Corporation, New York office and travelling expenses	20,057 71	0.0036
	$869,649 54	$0.1567
Less rents and interest	52,668 85	0.0095
Total cost of production	$816,980 69	$0.1472

Statement of Dividends Paid by Silver Cobalt Mining Companies

Name of Company.	Date of Incorporation.	Authorized Capital.	Capital Stock issued.	Par value per share.	Amount of Dividends and Bonuses declared to end of 1909.	Amount of Dividends and Bonuses declared during 1910.	Total of Dividends and Bonuses declared to Dec. 31, 1910.	Last Dividend or Bonus.	
								Date declared.	Rate per cent.
		$	$	$	$ c.	$ c.	$ c.		
Buffalo Mines, Limited	April 27, 1906	1,000,000	1,000,000	1.00	637,000.00	370,000	1,007,000.00	Dec. 5, 1910.	13
City of Cobalt Mining Company, Limited	Oct. 5, 1906 Jan. 7, 1909.	500,000 1,500,000	1,500,000	1.00	139,312.42	....	139,312.12	April 15, 1909	3
Cobalt Central Mines Company	Dec. 13, 1906	5,000,000	5,000,000	1.00	192,845.00	....	192,845.00	Aug. 25, 1909	1
Cobalt Silver Queen, Limited	April 1, 1906	1,500,000	1,500,000	1.00	315,000.00	....	315,000.00	Dec. 31, 1908	3
Coniagas Mines, Limited	Nov. 26, 1906	1,000,000	4,000,000	5.00	1,160,000.00	240,000.00	1,400,000.00	Nov. 1, 1910	3
Crown Reserve Mining Company, Limited	Jan. 16, 1907	2,000,000	1,999,957	1.00	1,591,932.60	1,061,288.40	2,653,221.00	Dec. 31, 1910	15
Foster Cobalt Mining Company, Limited	Feb. 14, 1906	1,000,000	915,588	1.00	45,000.00	....	45,000.00	Jan. 1, 1907	5
Kerr Lake Mining Company, Limited	Aug. 15, 1905	40,000	40,000	100.00	1,590,000.00	1,368,000.00	2,958,000.00	Dec. 13, 1910	370
La Rose Mines, Limited	Feb. 21, 1907	6,000,000	6,000,000	1.00	1,415,000.00	630,000.00	2,045,000.00	Dec. 10, 1910	2¾
McKinley-Darragh-Savage Mines of Cobalt, Limited	April 17, 1906	2,500,000	2,217,692	1.00	583,429.98	561,879.50	1,145,309.48	Nov. 14, 1910	15
Nipissing Mining Company, Limited	Dec. 16, 1904	250,000	250,000	100.00	4,355,000.00	2,127,500.00	6,482,500.00	Dec. 10, 1910	188
Right of Way Mining Company, Limited	July 13, 1906	500,000	499,518	1.00	324,643.93	....	324,643.93	Oct. 1, 1909	6
The Right of Way Mines, Limited	Sept. 11, 1909	2,000,000	1,685,500	1.00	33,710.00	134,840.00	168,550.00	Dec. 31, 1910	2
Temiskaming and Hudson Bay Mining Company, Ltd	July 29, 1903	25,000	7,761	1.00	1,171,911.00	162,981.00	1,331,892.00	Nov. 12, 1910	300
The Hudson Bay Mines, Limited	July 16, 1909	3,500,000	2,875,022	1.00	....	143,751.00	143,751.00	Nov. 11, 1910	1
Temiskaming Mining Company, Limited	Nov. 16, 1906 Jan. 1, 1908	2,500,000	2,500,000	1.00	509,156.25	275,000.00	784,156.25	Dec. 10, 1910	8
Trethewey Silver Cobalt Mine, Limited	May 30, 1906	1,000,000	1,000,000	1.00	461,998.50	200,000.00	661,998.50	Dec. 21, 1910	10
Total	....	....	....	....	....	7,275,239.90	21,802,179.58	....	....

The profit on production amounted to 72.62 per cent. of the value. Up to 31st December, 1910, there had been shipped from the mine 21,560 tons of ore and concentrates, containing 18,345,238.78 gross ounces silver, and a gross value including cobalt, nickel and arsenic paid for of $10,432,198.20, the net value received from the smelters being $9,438,908.30. In dividends a total of $6,012,500 had been paid. The reserves of developed and partly developed high-grade ore amount to 6,552,880 ounces silver, exclusive of milling rock on the dump and in the mines. The capital stock of the Nipissing Mines Company, the holding concern, is $6,000,000, and of the Nipissing Mining Company, the operating company, $250,000. The property covers 846 acres, of which 429 acres are classified as in the conglomerate formation, 176 in the Keewatin, and 241 in the diabase.

Crown Reserve

Ore production for the calendar year 1910 yielded the Crown Reserve Mining Company, Limited, the sum of $1,754,824.27. Mining and all other expenses, including development, depreciation, etc., amounted to $282,736.35, smelters' charges and deductions to $124,107.61, bonus to employees to $11,760.00, and royalty to Ontario Government (10 per cent. on value of ore at pit's mouth) to $154,119.41, leaving a profit of $1,185,100.90. Out of this were paid four quarterly dividends of 6 per cent., with 9 per cent. bonus added to each, making 60 per cent. in all, total $1,061,288.40. The surplus in Profit and Loss account at 31st December was $659,986.51. There were produced and shipped during the year 3,248,196 ounces of silver; up to the end of 1910 the mine had yielded 9,081,475 ounces of a gross value of $4,757,330.97. The company's capital stock is $2,000,000, and $2,653,221 in all were returned in dividends up to the end of 1910. The cost of producing silver was 11.97 cents per ounce. The characteristic ore of this mine is high grade, 1,637,905 pounds having been shipped during the year containing 2,958,379 ounces, or an average of 3,612 ounces per ton. Of low-grade ore 3.860,800 lbs. were sent out averaging 103 ounces per ton, and of bullion 90,041 ounces.

Kerr Lake

For the year ending 31st August, 1910, the Kerr Lake Mining Company's shipments were as follows:—

Grade of ore.	Lbs.	Silver contained. Ounces.	Average Silver contents per ton. Ounces.
First	1,311,120	2,473,128.71	3,775
Second	2,359,875	427,057.59	362
Dump	4,883,436	225,213.87	92
Total	8,554,431	3,125,400.17	

Sales of ore produced $1,528,983.34. Production and development cost $212,727.37; shipment, treatment and other charges, $115,669.79; administration and general expenses, $15,577.14, leaving a balance of profit of $1,198,220.24. There was paid in dividends $990.000. The cost of producing silver was 13.27 cents per ounce. The capital stock of the company is $3,000,000. The greatest depth at which the mine is being worked is 400 feet, on vein No. 3. The ore mined on this vein between 350 and 400 feet averaged 1,800 ounces in silver. Reserves of ore are estimated to contain from six to seven million ounces.

Coniagas

The output of the Coniagas mine for the year ending 31st October, 1910, was: from concentrates 949,901.35 ounces, from mine ore 979,629.65 ounces, total, 1,929,531 ounces. The total receipts were $1,010,413.67. The expenditure under the head of working account amounted to $256,524.69, the principal items being mining, $115,249.65, milling $40,561.08, fuel, oil and waste $25,095.85, camp expenses $15,637.93, head office

and administration $14,480.26, taxes and royalties $14,002.31. The balance, $753,888.98, was carried to Loss and Gain, and dividends amounting to $240,000 were paid, leaving a surplus of $952,402.90. From the beginning of operations to 31st October, 1910, there have been shipped from the mine a total of 5,323.1 tons of ore, containing 6,792,854 ounces of silver. The reserves are estimated as follows: Vein matter, No. 1 ore, 4,027 tons, containing 11,638,000 ounces of silver, wall rock (milling ore) 89,590 tons, containing 2,711,900 ounces, broken rock in mine (milling rock) 19,530 tons, containing 597,900 ounces, and broken ore on surface dump, 14,020 tons, containing 420,600 ounces; total 127,167 tons ore and rock, containing 15,368,400 ounces. This shows an increase of 21,167 tons ore and 2,868,400 ounces silver as compared with a year ago. The cost of producing silver is put at 13.285 cents per ounce, as compared with 15.219 cents the previous year. The capital stock of Coniagas Mines, Limited, is $4,000,000, and the company owns the stock of The Coniagas Reduction Company, Limited, at whose works, Thorold, Ontario, the ore and concentrates from the mine are treated.

La Rose

The fiscal year of La Rose Consolidated Mines, Limited, was changed to correspond with the calendar year, and the fourth annual report therefore covers only the period from 31st May to 31st December, 1910. During the seven months the shipments were:—

Material.	Tons.	Gross ounces Silver.	Net Value.	Per cent. of Total Value.
Silver-cobalt-nickel ore	901.897	1,444,259.93	722,791.09	69.44
Low grade silicious ore	913.701	146,565.04	58,759.26	5.64
Nuggets and bullion	5.620	126,761.11	66,001.57	6.34
Concentrates	559.391	400,988.17	193,382.06	18.58
Total	2,380.609	2,118,574.25	1,040,933.98	100.00

The average silver contents of the several grades were: Silver-cobalt-nickel ore 1,601.36 ounces, low-grade silicious ore 160.41 ounces, nuggets and bullion 22,555.36 ounces, and concentrates 716.83 ounces; the average of the whole being 889.93 ounces per ton. The net income for the period was $1,408,255.47, and the cost of mining and all other expenses, including smelter deductions, treatment, etc., $498,847.58, leaving a profit on production of $909,407.89. The dividends paid during the same time were $313,000.00. The cost of producing silver is given as 19.11 cents per ounce, and the ore reserves at 5,556,218 ounces of silver, of which 1,110,942 ounces are credited to the Lawson mine, and 531,650 ounces to the Princess. The total shipments to 31st December, 1910, were 20,341.18 tons, containing 10,809,885.76 ounces of silver, and a gross value of $6,027,996.67. The company's authorized share capital is $7,500,000.

McKinley Darragh-Savage

From the McKinley-Darragh mine there were recovered in 1910, 2,226,766 ounces of silver, and from the Savage mine, 412,778 ounces, a total of 2,639,544 ounces, the value of which was $1,126,856.53. The cost of production at the mines is placed at $254,794.53, of marketing the silver, $124,596.86, and of other items of outlay, $70,824.41, leaving a profit of $976,610.73, or adding receipts other than from sales of ore, $983,043.55, of which $561,879.50 was paid out in dividends. Silver was obtained from the products of the mine classified as follows:

Material.	Tons.	Ounces silver.	Average silver contents per ton.
Nuggets	1.543	28,011	18,173.0
No. 1 Ore	439.869	974,996	2,216.5
Jig Concentrates	445.563	823,280	1,847.7
Sand do	746.229	601,118	805.9
Slime do	669.825	179,639	268.1
Miscellaneous	124.378	32,167	258.6
Total	2,427.407	2,639,541	Av. 1,087.3

The cost of silver at the McKinley-Darragh mine was 17.05 cents per ounce, and at the Savage 17.34 cents. Up to the end of 1910 there had been shipped from the former mine, 4,877,086 ounces, and from the latter 470,912 ounces, a total of 5,365,998 ounces. Ore reserves at the McKinley-Darragh are estimated at 104,450 tons, carrying, 4,894,000 ounces; and at the Savage, 31,210 tons carrying 1,147,500 ounces; or for both, 135,660 tons, with contents of 6,041,500 ounces silver. The capital of the McKinley-Darragh-Savage Mines of Cobalt, Limited, is $2,500,000.

In the following table are summarized the salient particulars of the foregoing reports. It will be seen that the average cost of producing silver in this group of mines is 16.34 cents per ounce, and that the estimated reserves of silver amount to over 40,000,000 ounces, not including the Crown Reserve, the nature of whose property makes it more than usually difficult to reduce any estimate to definite figures. It is apparent that if the view taken of their properties by these companies is correct, there is still a reasonably long life ahead of the Cobalt camp, leaving out of account altogether the large number of other producing properties not included in the list, and the probability, which is practically a certainty, of other veins and deposits now unknown being discovered as development goes on.

Mine.	Silver produced in year.	Gross Income.	Gross Expenditure.	Net Income.	Cost of producing Silver per ounce.	Total Silver produced by mine to date.	Estimated Reserve of Silver.
	Ounces.	$	$	$	cents.	Ounces.	Ounces.
Nipissing........	5,597,779	3,036,753.04	869,619.51	2,167,103.50	14.72	18,345,239	6,552,880
Crown Reserve...	3,248,196	1,757,824.27	572,723.37	1,185,100.90	11.97	9,081,475	not given
Kerr Lake........	3,125,400	1,542,191.51	343,971.30	1,198,220.24	13.27	not given	6,500,000
Coniagas.........	1,929 531	1,010,413.67	256,524.69	753,888.98	13.28	6,792,854	15,368,400
La Rose..........	2,118,574	1,408,255.47	498,847.58	909,407.89	19.11	10,809,886	5,556,248
McKinley-Darragh-Savage	2,639,514	1,433,259.35	450,215.80	983,043.55	17.05	not given	6,041,500
Total........	18,659,024	10,188,700.34	2,991,935.28	7,196,765.06	16.34	....	....

The Question of Power

The mines at Cobalt are now enjoying the advantages of water-power developed on the Montreal and Metabitchewan rivers, and transmitted both as compressed air and electricity. The power plants are situated at Ragged Chute and Hound Chute on the Montreal river, and at the foot of Bass lake, near the mouth of the Metabitchewan. At the first named place the Cobalt Hydraulic Power Company has installed an air-compressing plant on a large scale, and pipes the compressed air to Cobalt. The development here is 4,000 or 5,000 horse power. At Hound Chute the Cobalt Power Company has an electrical equipment capable of delivering about 3,000 horse power. The British Canadian Power Company, formerly Mines Power, Limited, has the plant at Bass lake, its capacity being about 8,000 horse power. This is transmitted to Cobalt in the form of electricity, part of it being then utilized in the compression of air for the operation of drills, etc., in the mines.[2]

The advent of hydraulic power has been a decided advantage to the camp, inasmuch as the power is delivered at a cost of little more than one-third of that produced by the consumption of coal, but it has not been without its drawbacks. Interruptions were not unknown at first, but these were quickly eliminated by greater attention to the equipment. There was also some objection to the use of the compressed air from Ragged Chute by reason of its deficiency in oxygen and consequent inability to support the burning of candles, thus alarming the miners, who suspected bad air. Acetylene lights, however, got rid of this difficulty, and no ill effects were produced upon the

[2] For a description of these power installations, see 19th Report, B. of M., Part I., pp. 133-140.

workmen by the smaller percentage of oxygen. The chief trouble is more fundamental. The cold northern winters, with their infrequent thaws, have the effect of rendering the general drainage system very torpid, and the run-off of water is reduced to a minimum in the months of January, February and March. If the proverbial "January thaw" comes to the relief, the situation is mitigated, but if this fails to arrive or is inadequate to replenish the reservoirs, the water runs through the turbines much faster than it is replaced, and a scarcity of water and reduction in power necessarily follow. The winter of 1910-11 was unusually steady, and in February it began to be apparent that the water-powers on the Montreal and Metabitchewan were likely to be seriously affected. March saw no improvement, and as the return of spring, which the previous year was unusually early, was in 1911 unusually late, the shortage of water and power continued well into April. Such of the mines as had retained their steam plants were obliged to put them again into commission, but in a number of cases steam power was unavailable, and the general effect upon the camp was to cause a decided drop in production. It is possible that the output of silver for 1911 will reflect this partial stoppage of the mines. The remedy is to more nearly equalize the flow of these rivers, which can only be done by a system of dams at the outlets of the lakes and river expansions, thus permitting storage of the freshet waters for use in the low-water periods of summer and winter.

Cobalt

The situation with regard to the cobalt contents of the ores from the mines of Cobalt remains practically as was described in last year's Report.[3] Cobalt oxide as such and in admixture with nickel oxide, is now being produced by the refineries at Deloro and Thorold. Exports, chiefly of the mixed oxides, are made to the European market, but there are shipments of the finished article as well. Attempts are being made to prevent a further fall in the price of cobalt oxide, which is now in the neighbourhood of 75 cents per pound, but the enforced production of the ore, and the practically enforced production of the oxide itself, will almost inevitably lead to a still further lowering of the market value.

Mr. Elwood Haynes, president of the Haynes Automobile Company, Kokomo Indiana, has conducted an interesting series of experiments with cobalt and chromium, by which he has succeeded in obtaining a number of alloys of these metals, some of which give promise of commercial usefulness. Speaking of one of these alloys, containing 75 per cent. cobalt and 25 per cent. chromium, Mr. Haynes says[4]:—

A pocket-knife blade and several table-knife blades were made from this material and were found to be satisfactory in every respect. One of these table-knife blades has now been in use for more than two years in the kitchen, where it was used for all sorts of purposes, such as cutting bread, turning griddle cakes, peeling and paring vegetables, and for various other purposes, such as are known only to the culinary art. After all this use and abuse, the knife shows not the slightest trace of tarnish, and has held its lustre so well that when exposed to the sun it shows a reflection which dazzles the eyes. . . . An alloy of 75 per cent. cobalt and 25 per cent. chromium, to which small quantities of other metals are added, is not only sufficiently hard for good edge tools, but is quite tough and can be bent much beyond its elastic limit without cracking; resembling in this respect the alloy steels, but, generally speaking, it is much harder. A bar of the alloy, $\frac{1}{4}$-inch square, can be bent cold at right angles without showing any signs of cracking. . . . The colour of the alloy lies between that of steel and silver, and is specially pleasing in bright light. The alloy is also readily polished, but requires special treatment in order to develop its highest lustre.

The most remarkable property of this combination, however, is its resistance to corrosion. It is equalled in this respect only by gold and the metals of the platinum group. It is attacked slowly by dilute hydrochloric acid, and somewhat vigorously by the strong acid, especially when heated. Momentary exposure, however, to either

[3] See Bur. Mines, Vol. XIX. (1910), Part I., p. 24.

[4] "The Production of Alloys of Nickel and Cobalt with Chromium," in *The Iron Trade Review*, August 4, 1910, pp. 221-223.

dilute or strong hydrochloric acid has practically no effect upon the metal. Both strong and weak sulphuric acid attack it very slowly when cold, and not very rapidly even when heated. Nitric acid is totally without action upon it, and a polished piece of the alloy may be boiled in it for hours without affecting the lustre of the metal in the slightest degree. Solutions of the caustic alkalies are also totally without action upon it even when boiled for hours. The alloy is likewise proof against all atmospheric influences, whether the air be moist or dry, and retains its brilliant lustre for months or even years, under severest conditions. Even sulphuretted hydrogen, when present in the atmosphere in large quantity, is totally without influence upon it.

Mr. Haynes regards this substance, to which the name "stellite" has been given, as particularly suitable for the manufacture of small cutting instruments, since it takes an edge comparable to that of tempered steel. He states:

It is especially adapted to the manufacture of pocket knives, on account of the beauty of its colour and the brilliancy of its lustre, both of which remain permanent under all circumstances, thus giving the blades a particularly attractive appearance. Knives of this description may be used for cutting fruit without danger of marring their lustre in the slightest degree. Alloys in certain proportions will also doubtless find a wide use for surgical instruments, since they resist perfectly all sterilizing solutions. The alloy is perhaps better adapted for table cutlery than anything that has ever yet been produced. We all know too well that a silver-plated knife, for example, is ill adapted for any service requiring a sharp edge, and it cannot be sharpened without destroying the plating. Steel knives, on the other hand, while they cut well, require endless labour to keep them in presentable condition, and at best, they are unsightly in appearance.

The alloy is also of considerable interest to the chemist and physicist. It is admirably adapted for the manufacture of fine weights for balances, scrapers, spatulas and other laboratory appliances. To the physicist it furnishes a material at once hard, lustrous and untarnishable, and hence well adapted for the manufacture of fine weights, measuring instruments and various small tools.

The alloy is also particularly well adapted for the manufacture of standard weights and measures, such as the gram, kilogram, meter, etc., and it is difficult to see in what respect it is inferior for this purpose to the expensive platinum-iridium alloys now in use.

The alloy could readily be made into laboratory vessels, cooking utensils, spoons, forks, etc., and is limited in this respect only by its cost.

Regarding the cost of stellite, no definite statement can at present be made. It is probable that for the better kinds of cutlery the selling price would not be materially greater than that of the steel now employed. It may be that in this or similar directions an outlet will be found for the cobalt which the mines of the district of that name are now forcing upon an unwilling market.

Bounty on Cobalt Oxide

The bounty on cobalt oxide provided by the Metal Refining Bounty Act (7 Edward VII., chap. 14) was first called for last year, both the Deloro Mining and Reduction Company and the Coniagas Reduction Company having made shipments of the oxide. The bounty is at the rate of six cents per pound of metallic cobalt contents. The theoretical composition of cobalt oxide is 78.66 per cent. cobalt and 21.34 per cent. oxygen, but in actual practice the commercial article contains impurities which reduce the cobalt to 69 or 70 per cent., without, however, interfering with its color-producing properties. The great use of cobalt oxide continues to be for imparting the beautiful and characteristic cobalt blue to the fine chinaware made in France, England and Germany. The reason for exporting the mixed oxides of cobalt and nickel is found in the fact that the cobalt manufacturers of Europe prefer to make the separation themselves, thus enabling them to market the product under their own established brands. The quantity of oxide consumed annually is believed not to exceed 300 or 350 tons, which is much below the equivalent in ore produced every year by the silver mines of Cobalt. Previous to the opening of these mines a small quantity of cobalt was recovered from the nickel-copper mattes of the Sudbury district, but this source of the material is no longer utilized. Indeed, it had fallen into disuse some time previous to the discovery of Cobalt, when the product of the Bessemer converter took the place

of the old low-grade matte in the treatment of the nickel-copper ores. The blowing process to which the molten matte was subjected while in the converter was credited with expelling the cobalt contents.[5]

The total quantity of metallic cobalt contained in the ores raised from the mines of Cobalt last year is estimated at 1,098 tons. Out of this production, the mining companies were paid for 379 tons only, for which they received $54,699, or at the rate of 7.2 cents per pound.

Nickel

There were raised from the nickel-copper mines of Sudbury last year 652,392 tons of ore, of which 628,947 tons were smelted in the blast furnaces and put through the converters. The product was 35,033 tons of Bessemerized matte, 23.6 tons of ore being thus required on an average for one ton of matte. In this quantity of matte there were contained 18,636 tons of nickel, last year's output, 13,141 tons, being exceeded by 5,495 tons, or over 41 per cent. The production of 1910 was much the largest since the nickel mines of Sudbury were opened, a quarter of a century ago, and stamps this field as being the most important source of nickel in the world. The value of the nickel contents of the matte, on the basis of what it is worth—or estimated by the producers to be worth—at the point of production is $4,005,961.

To the output of the Sudbury mines must be added, for the sake of completeness, the nickel contents of the silver ores raised at Cobalt, estimated to amount to 504 tons, bringing the total yield of nickel in 1910 up to 19,140 tons. Nothing is added to the value of the production by the nickel from Cobalt, since the mining companies are paid nothing for it. It cannot be doubted, however, that at least a portion of this nickel yield finds its way into use in the arts, since it must be separated from the cobalt, in order to obtain the latter.

The Sudbury mines are operated by two companies—The Canadian Copper Company, and the Mond Nickel Company.

The former's smelting works are at Copper Cliff, where during the last few years there has been established one of the largest and best-equipped plants of the kind to be found anywhere, costing in the neighbourhood of $4,000,000. Power for operating the mines and works is developed at High Falls on the Spanish river, about 28 miles from Copper Cliff, where there is a natural drop of about 65 feet, increased by damming to 85 feet. About 12,000 horse power can be obtained here, and costs delivered at Copper Cliff about $15 per horsepower-year. Exclusive of capital charges the cost is about $6. The cost of the water power development was about $750,000. Ore is taken for the most part from the Creighton mine, which furnished 391,575 tons out of the 508,404 tons raised by the company in 1910. Of the remainder, 89,219 tons came from Crean Hill, 26,381 tons from No. 2, and 1,229 tons from the Vermilion. Creighton ore contains about 1.5 per cent. copper, and 4.5 per cent. nickel. The workings began as open-cast, the ore coming right to the surface, where the lens was about 400 feet wide. After an opening had been made the full width of the ore and about 700 feet long, to a depth of 190 feet, it was found advisable to resort to the usual method of working by shafts and levels. At the fourth level the ore body has a width of about 250 feet, and ore has been proven for 1,500 feet on the strike of the deposit. The mine is estimated to show 5,000,000 tons of ore without including certain extensions, or about 13 years' supply at the present rate of extraction. The Canadian Copper Company estimates that it has "proved supplies of ore" in its nickel-bearing lands amounting to at least 30,000,000 tons.[6] Crean Hill admirably supplements Creighton for smelting

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[5] A recent issue of *La Nature* states that the whole of the cobalt now used in the world comes from the Cobalt mines. The deposits in New Caledonia, which once enjoyed a monopoly, have ceased production, being unable to compete with those of Ontario at the low price to which cobalt oxide has fallen.

[6] *See* "Organization and Equipment of The Canadian Copper Co.," by Alexander Gray, p. 20.

purposes, the silicious character of the ore correcting the more basic nature of the material from Creighton. Since the beginning the ore of the Crean Hill is said to have averaged 6.35 per cent. of the combined metals, the copper being in excess.

The Mond Nickel Company's smelting plant is at Victoria Mines in the township of Denison, and on the Sault branch of the Canadian Pacific railway. This situation is convenient to the Victoria mine, from which until lately the company has drawn the bulk of its ore supply. In view of the fact that most of its ore now comes from the Garson mine, some distance to the northeast of Sudbury, the company is contemplating the removal of its works to a point near Rumford on the main line of the C. P. R., where the distance for ore haulage will not be so great. Last year, out of a total of 143,988 tons of ore raised, 93,542 tons were extracted from the Garson mine, 42,488 tons from Victoria No. 1, and 7,958 tons from Victoria No. 4. At Wabageshik falls on the Vermilion river, the Mond Company have for some years been generating water power for use at Victoria Mines plant and mines, and to serve a like purpose at their new location they have obtained from the government the lease of a power on the Wahnapitae river not far from its mouth.

Monel Metal

Reference has been made in several of the Bureau's Reports to "Monel metal," an alloy of nickel and copper which has been placed on the market by the Canadian Copper Company, and which is produced by that company without separating the metals or either of them from the matte. In fact, it is asserted that the proportions in which the nickel and copper occur in the Canadian Copper Company's ores are almost precisely those required for the alloy, which are about 67 per cent. nickel and 27 per cent. copper, and that by careful attention to the furnace charge a Bessemer matte can be produced within one per cent. of that required in making Monel metal. Considerable quantities of this alloy are now coming into use. It is claimed to possess great strength and to be practically non-corrodible. It has been employed as castings in the manufacture of propellers for vessels of the United States navy and private yachts, in pump linings, steam turbine nozzles and valve fittings for superheated steam, in dairy machinery, refrigerating plants, and pickling apparatus in steel mills; in rod form, for pump rods, bolt and nut stock, steam turbine parts, stock for drop forgings, electrical apparatus, motor boat shafting, pickle pins and valve stems; as sheets, for roofing railway terminals and other large buildings, for mine screens and chutes, smelter roofs, skylights and window frames, boat sheathing, cooking utensils and chemical apparatus, also for steam turbine blades; in the form of wire for wire cloth, motor cycle spokes, rope for mine hoists and cableways, nails, screws, rivets, etc.; and many other applications where high tensile strength, combined with non-corrosive features are essential.

The use of nickel for coinage purposes is spreading. In 1909 the Government of Turkey was authorized to put out an issue of coins made of nickel or aluminium. The latter metal, upon being tested, not having given satisfactory results, nickel was decided upon, and it has been resolved to issue 120 millions of 5-para pieces, 120 millions of 10-paras, 70 millions of 20-paras, and 20 millions of 40-paras, in all 330 million pieces. The money is all to be coined in four years and issued in twenty.

The development of nickel-copper mining and smelting during the last five years is shown by the figures contained in the following table:—

Table IX.—Nickel-Copper Mining, 1906 to 1910

Schedule.		1906.	1907.	1908.	1909.	1910.
Ore raised	tons	313,811	351,916	409,551	451,892	652,392
Ore smelted	"	340,059	359,076	360,180	462,336	628,947
Bessemer matte produced	"	20,364	22,041	21,197	25,845	35,033
Nickel contents	"	10,776	10,602	9,563	13,141	18,636
Copper contents	"	5,260	7,003	7,501	7,873	9,630
Value of Nickel	$	3,839,419	2,270,442	1,866,059	2,790,798	1,005,961
Value of Copper	"	806,413	1,020,913	1,062,680	1,122,219	1,374,103
Wages paid	"	1,117,420	1,278,694	1,286,265	1,234,904	1,698,184
Men employed	No.	1,117	1,660	1,680	1,796	2,156

The valuation of the nickel and copper contents of the mattes in the above table is that placed upon them by the producers themselves.

In last year's Report[7] the remark was made that the Mond Nickel Company has had a successful career, the proof being supplied by statistics of this company's earnings and dividends paid, quoted from the London *Statist* of July 2, 1910. The remark may here be repeated as applied to the Canadian Copper Company. In the pamphlet by Mr. Alexander Gray, already cited, which was issued and circulated by the company itself, it is stated[8] that "a horizontal valuation of $5 to $6 per ton (of ore) mined, as a com-"promise, might not be so wide of the mark. A net profit of $1.50 to $2.00 per ton mined "would then be a conservative, if unauthorized, estimate. That would mean a yearly "profit of $522,900, or $697,200 as applied to 1909 mining operations. The 13,000,000 "lbs. of the nickel disposed of in 1909, it is claimed, brought a profit of 7½ cents per "pound spread over mining, smelting and refining charges." At this rate, the profit on the ore smelted in 1910 would be from $726,253 to $968,338, and on the ultimate product, or nickel marketed, of $2,377,200. This is not a bad showing for a Canadian mining company, even if it covers also the operations of a refining works in the United States. Yet no one will grudge the substantial reward which is now being and has for a number of years been reaped by the pioneer company of the Ontario nickel mining industry, whose career has been marked by self-reliance, courage and persistency, and whose business record in Northern Ontario stands second to none.

The only other important source of nickel is the island of New Caledonia, whose output, however, in proportion to the whole, is now much less than that of Sudbury. *Société le Nickel*, whose production is of New Caledonian ores, operates refineries in France, England and Germany. From 1900 to 1909 the French production fell from 1,700 to 1,200 tons, while that in England rose from 1,500 to 2,800 tons, and in Germany from 1,400 to 3,100 tons. Thus in 1909 the total output of nickel from New Caledonia was 7,100 tons. In the same year the yield from the Sudbury mines was 13,141 tons. *Le Nickel* proposes to erect a refinery in New Caledonia to treat the ore on the spot. (See Le Bulletin du Commerce, Noumea, New Caledonia, 1 April, 1911.)

Other statistics of the nickel-copper industry for the past year show that 24,651 cords of wood valued at $76,705 or $3.11 per cord were used, mostly in "heap-roasting" the ore, and 95,172 tons of coke costing $696,851 or $7.32 per ton, were consumed in reducing the ore to matte.

Copper

The copper product of Ontario in 1910 amounted to 9,630 tons, valued at $1,374,103, being an increase over the output of 1909 of 1,697 tons in weight and $247,088 in value. It was all contained in the nickel-copper mattes produced by the Sudbury smelters. The only non-nickeliferous mine which contributed to the total was Bruce Mines, a quantity of ore from which was shipped to Victoria Mines and used by the Mond Nickel Company for lining the Bessemer converters which produced the matte.

Small quantities of copper ore were raised by the Hermina Mining Company, the Parry Sound Copper Company and the Meridian Bay Mining Company, but none was shipped by any of these companies.

Iron Ore

The shipping iron mines last year were the Helen, Moose Mountain, Atikokan and Mineral Range. Their combined output was 230,656 tons valued at $513,721, a shortage as compared with 1909 of 33,121 tons of ore and $131,901 in value. Of the output 112,246 tons were hematite, and 118,410 tons magnetite.

[7] Page 20. [8] Page 21.

A large deposit of magnetic ore has been under development by the Lake Superior Corporation at Magpie, in the Michipicoten district, 15 miles northeast of the Helen mine. Some seventeen drill holes have been put down, to an aggregate depth of several thousand feet, and Mr. R. W. Seelye, manager of the company's mines department, computes that between 15 and 20 million tons of ore have been shown up. The ore is metamorphic after siderite, the sulphur contents and carbon dioxide being, of course, objectionable for furnace practice. A series of experiments was undertaken by the company with the view of determining the best method of eleminating these undesirable elements. The results, Mr. Seelye states, are such as to leave no doubt that the ore can be successfully treated and the deposit utilized.

Search for bodies of workable ore goes on unremittingly, not only in northern, but also in eastern Ontario. Special interest has been aroused by the endeavour to determine the extent and value of the large iron carbonate outcrops on the Mattagami river, and the report of Mr. M. B. Baker who visited the region for the Bureau last year presents the data available at present on this point. Reports of large surface showings of iron ore are brought from the neighbourhood of Bending and Stony lakes, west of the main line of the Canadian Pacific railway at Ignace station. In the eastern part of the Province a considerable body of magnetite is said to have been discovered along the line of the Kingston and Pembroke railway not far from the Wilbur mine. Preparations are also being made for the erection of magnetic concentration plants at Collins Bay, near Kingston, and at Trenton.

Pig Iron and Steel

There are now eight blast furnaces producing pig iron in Ontario, distributed as follows: Algoma Steel Company, Sault Ste. Marie, two; Hamilton Steel and Iron Company, Hamilton, two; Atikokan Iron Company, Port Arthur, one; Canada Iron Corporation, Midland, two; Standard Chemical Company, Deseronto, one. The combined product in 1910 was 447,351 tons of pig iron, valued at $6,975,418, or an average of $15.59 per ton. In 1909 the furnaces were seven in number, and the production was 407,013 tons worth $6,301,528. The additional furnace blown in last year was at the works of the Canada Iron Corporation, Midland. There were made at Sault Ste. Marie and Hamilton 331,321 tons of steel, 233,621 tons of the pig product at the two places being used in the manufacture. The plant at Sault Ste. Marie makes steel rails exclusively, while at Hamilton, basic open hearth ingots are produced, a large tonnage of which is further developed into billets, forgings, spikes and bar iron and steel.

The blast furnace operations for the past year are shown in the following statistics:

Ontario ore smelted	tons	143,284
Foreign " "	"	678,890
Scale and mill cinder smelted	"	15,584
Limestone for flux	"	248,750
Coke for fuel	"	471,493
Value of do		$2,237,039
Charcoal for fuel	bush.	1,133,419
Value of do		$107,675
Pig iron product	tons	447,351
Value of do		$6,975,418
Steel product	tons	331,321
Value of do		$7,855,407
Workmen employed	No.	2,120
Wages paid		$1,443,904

At Welland, where cheap electric power is available, a considerable industrial development is going on. Among the plants established there is that of the Electro-Metals, Limited, where ferro-silicon is made from iron ore and silica (flint, sandstone

and sand). The product contains about 50 per cent. silica. Some 4,343 tons of iron ore were used last year. Seven electric furnaces are operated and about 115 workmen employed.

In the table which follows are set forth details of the iron and steelmaking industry of the Province during the last five years:

Table X.—Production Iron and Steel, 1906 to 1910

Schedule.		1906.	1907.	1908.	1909.	1910.
Ontario ore smelted	tons	101,569	120,156	170,215	220,307	143,284
Foreign ore smelted	"	396,463	388,727	342,747	543,544	678,890
Limestone for flux	"	153,702	171,037	179,741	226,991	248,750
Coke	"	304,676	326,937	322,817	436,707	471,493
Charcoal	bush.	811,926	1,849	....	973,413	1,133,419
Pig iron	tons	275,558	286,216	271,656	407,013	447,351
Value of pig iron	$	4,554,247	4,716,857	4,390,839	6,301,528	6,975,418
Steel	tons	167,026	237,855	172,108	296,031	331,3.1
Value of steel	$	4,202,278	4,168,127	4,397,082	6,759,960	7,855,407

Zinc Ore

The quantity of zinc ore raised and shipped last year was 576 tons, valued at $5,760 or $10 per ton.

Materials of Construction

Materials of construction include building brick, lime, stone and cement. In presenting statistics regarding the first three of these articles it is difficult to entirely separate the data pertaining solely to them, so far as labour and wages are concerned, for the reason that in many cases other branches of manufacture are carried on, and other articles produced, from the same raw material and with the same workmen. For instance, drain tile is quite commonly made in brickyards, comparatively few tileyards being carried on as distinct from yards in which brick is made. The burning of lime is usually a separate industry, but is sometimes associated with the quarrying of limestone for construction or other purposes. Again, the small limekiln operated by a farmer or his sons on his own land still survives in some localities, and in such cases it is generally impracticable to assign any definite number of days as having been spent at the limekiln, or any definite sum paid out or earned for labour. This occasionally happens with brick as well. The evolution of the brick-making, lime-burning and quarrying industries, however, is proceeding on the same lines as that of practically all other industries; small producers are disappearing through the pressure of competition, or by the familiar process of "merging" or "consolidation," which relieves the market of too many rivals for business. The larger concerns, however, have advantages from a statistical point of view; more accurate records are kept, and business details, are as a rule, well looked after. The manufacture of cement is almost wholly a distinct industry, and is not subject to the difficulties mentioned.

Brick

The number of common building brick made in 1910 was 304,988 thousand, worth $2,374,287, as compared with 216,308 thousand, worth $1,916,147 in 1909—an increase in both number and value of over 23 per cent. The average value placed upon the output in 1910 was exactly the same as in 1909—$7.78 per thousand. There was a very active demand for brick throughout the year, the city yards in particular being barely able to supply the requirements of the building trade, and this condition of affairs is likely to extend into 1911. For the most part, the cities and towns of Ontario are made of brick, the manufacture of which has been much improved of late years, and which lends itself to variety and novelty in building effects more readily than stone, while being less subject to fire than wood.

Pressed brick, averaging in cost $10.37 per thousand, were made to the number of 44,204,295, the value being $458,596. For the moment, popular taste seems to have veered from the smooth, almost polished surface of the first-class pressed brick with its uniformity of coloring, which sprang into demand a number of years ago, to the rougher, less regularly formed hard-burned brick now in favour, in which all shades of colour are not only permissible, but desired. In 1909, 53,166,941 pressed brick were turned out, valued at $490,571.

The use of paving brick has not become so general as at one time appeared probable. A good vitrified brick makes a durable, easily repaired roadway, but it is undeniably noisy, and to this disadvantage, more than to any other feature, appears to be due the slow progress paving brick has made towards popularity. In 1909, 4,607,620 were produced in Ontario, valued at $73,700, while last year, the output fell to 3,799,025, worth $70,648.

The total value of all kinds of brick made in 1910 was $2,903,531, in the manufacture of which, including tile, 3,559 men were employed, receiving as wages $1,423,751. The average yearly wage per man was therefore $400. In 1909 it was only $303, and it is therefore evident that the brickmaking season, which for the most part extends over the months of late spring, summer and early autumn only, was last year stretched out to an unusual length.

Lime and Stone

The limestone formations of older Ontario are widespread; indeed, the soil on which resides much the greater portion of the Province's population is underlaid by limestone, and this fact ensures an ample supply of lime throughout the settled part of Ontario at reasonable cost. The newer districts which have so far been opened up for settlement are not on the whole so well provided for in these respects, especially those regions where the pre-Cambrian rocks are hidden, in some places scantily enough, by the sandy and gravelly deposits of glacial origin. In the so-called clay belt, however, the southern extension of which is traversed by the Temiskaming and Northern Ontario railway, and the main body by the Transcontinental line, the geological and soil conditions of older Ontario are more nearly repeated, and settlers in these regions need fear scarcity neither of lime nor brick.

In 1910 the lime-kilns of Ontario produced 2,889,235 bushels of lime, valued at $474,531, a somewhat larger output than in 1909, when the figures were given us 2,633,500 bushels, valued at $470,858.

Of building and crushed stone the production last year had a value of $761,126, as compared with $660,000 in 1909. Much of the stone is used in the construction of buildings, the better qualities in the superstructures and the rougher or less valuable sorts in the foundations, and the broken or crushed material is utilized for pavement foundations, macadamized roads, and when of limestone, for flux in blast furnaces. High-grade carbonates of lime are used also for certain chemical purposes, among others, the manufacture of lime-sulphur solutions for the spraying of fruit trees, etc. Dolomite carrying a high percentage of magnesia is also used in making Epsom salts.

Some large slabs of fine marble taken from quarries at Bancroft and shown in the mineral display made by the Bureau of Mines at the Toronto Exhibition in 1909 and 1910, drew attention to these deposits, and the material has been used for dados and halls, etc., in some public buildings recently erected in Toronto. A variety of colorings is obtained, one being a blending of mauve and gray in which the shades harmonize beautifully, and another a striking mixture of red and black. The stone itself is a species of dolomite. From Marble Bluff, in the County of Lanark, are obtained handsome serpentines of various shades of green, which bid fair to come into demand. The companies interested are The Ontario Marble Quarries, Limited, Bancroft, and the Central Ontario Granite and Marble Company, Limited, Trenton, for the beds in Bancroft, and the North Lanark Marble and Granite Quarries, Limited, St. Catharines, in those of Lanark county. The

marble deposits of Ontario, as yet largely undeveloped, will undoubtedly in the future largely replace the quarries of Italy and Tennessee as a source of this decorative material, since it is apparent that in beauty and variety of markings, as well as in size of blocks, they can easily meet foreign competition. Specimens showing a wide range of shades have also been brought from the unsurveyed territory near lake Nipigon, which when polished are very pleasing to the eye.

Considerable granite was taken out last year by Messrs. David J. Gordon and Son from their quarries near Gananoque.

Portland Cement

The manufacture of Portland cement in Ontario began in 1891, and each successive year has seen a larger production than the one before. In 1910, 2,471,837 barrels were made, having a value of $3,144,343, the average price per barrel at the works being $1.273, a slight increase over that of 1909, when it was $1.257. In the latter year the production amounted to 2,303,263 barrels, worth $2,897,348.

The Canada Cement Company, by which title the "merger" is known which in 1909 united under one management the largest producers in Ontario as well as several in other parts of Canada, produced much the larger share of the cement made in 1910. This company operated plants at the following places: Port Colborne, Marlbank, Belleville (Lehigh), Owen Sound and Lakefield, the last-named to a small extent only. Outside of the "merger," the National Cement Company of Durham was the largest producer; others were Kirkfield Portland Cement Company, Kirkfield; Imperial Cement Company, Owen Sound; Ontario Portland Cement Company, Blue Lake; Hanover Portland Cement Company, Hanover; Superior Portland Cement Company, Orangeville; Maple Leaf Portland Cement Company, Atwood; and Sun Portland Cement Company, Owen Sound. The Ben Allen Portland Cement Company was idle and the Crown Portland Cement Company made no return. In the various factories 1,233 men were employed who received in wages $713,550.

The tendency in the manufacture of Portland cement is strongly towards the use of solid rock for supplying the carbonate of lime, rather than shell marl. At the outset of the industry, the latter was exclusively employed, but it was found more economical to raise and grind the rock than to dredge the marl and handle the large proportion of water accompanying it. The rock has the additional advantage of occurring in almost inexhaustible supply, as contrasted with the limited deposits of marl. It does not appear that there is any marked difference in the quality of the resulting cement.

The uses to which Portland cement is being put, are almost endless. It is taking the place for certain purposes, not only of brick and stone, but of iron and wood. One of the latest employments of this article, for which it answers admirably, is in making the electric light poles with which the hydro-electric commission is studding the streets of Toronto.

Other Clay Products

Of drain tile the quantity returned as having been made in 1910 was 21,028,000, valued at $318,456, a considerable reduction from the output of 1909, which was 27,418,000, worth $363,550.

Sewer pipe to the value of $357,087 was made last year, an increase of $45,257, as compared with 1909. Three factories were in operation, namely, Dominion Sewer Pipe Company, Swansea, Ontario Sewer Pipe Company, Mimico, and Hamilton and Toronto Sewer Pipe Company, Hamilton.

From the potteries of the Province, goods valued at $51,489 were turned out in 1910. This compares with $43,214 worth made in 1909. The growth of the pottery industry in Ontario is slow. In 1891, the first year of the Bureau's existence,

the production amounted to $45,000. Doubtless the explanation is to be found in the scarcity or absence of clay suitable for the finer kinds of ware, the articles now made being for the most part coarse goods such as flower pots, jardinieres, etc. Two or three establishments manufacture higher grade goods, such as the so-called "stoneware," also majolica ware, but the clay for these is imported. Perhaps when population flows over the height of land the kaolinic clays found in the valleys of some of the north-flowing streams may be put in requisition to supply the wants of the inhabitants of newer Ontario.

Arsenic

From the silver-cobalt ores of the Cobalt mines treated in their plants, the Copper Cliff, Deloro and Coniagas refining companies recovered and marketed 1,524 tons of arsenic in the form of refined arsenious acid or white arsenic. According to the estimate made on a previous page, the total quantity of arsenic in the Cobalt ores raised during the year was 4,897 tons, so that 3,373 tons are to be accounted for as contained in the ores and concentrates exported and treated elsewhere. Beyond doubt a considerable proportion of this arsenic is lost, and the full arsenical contents of the ores raised at Cobalt consequently fail of utilization.

The value placed by the smelting companies in their returns to the Bureau upon the 1,524 tons of white arsenic was $70,709, an average of 2.31 cents per pound. The consumption of arsenic has not kept pace with the increase in supply, and since the opening of the Cobalt mines the price has fallen from six or even seven cents per pound to less than three. Under these conditions, there is no incentive for the opening up of new sources of this article. There are many deposits of mispickel, some of them auriferous, in Ontario, but unless the gold contents can be extracted at a profit without reference to the arsenic, there is little likelihood of their being developed while present conditions prevail.

The uses of arsenic are many—in medicine, as an insecticide, in the manufacture of pigments, and also in importing a peculiar brilliancy to plate and other glass.

Iron Pyrites

The pyrite deposits of Ontario yielded in 1910 33,812 tons of ore, worth at the mines $98,353, an average of $2.90 per ton. The output in 1909 was 28,946 tons valued at $78,170. The largest producer was the Helen iron mine, where the pyrite occurs under unusual conditions. Bodies of finely granular ore are met with enclosed in iron ore, and much care is required in handling them, since when cut into the pyritic sand runs out almost as freely as water. The Nicholls Chemical Company, whose mines and acid works are at Sulphide, Hastings county, raised a good deal of ore, and has recently much enlarged its acid-making plant. The Northland mine at Rib lake, Temagami Forest Reserve, was leased by Mr. C. B. Stranahan and worked by him from 23rd May to 1st September, 1910, during which time considerable ore was raised and shipped. The Canadian Sulphur Ore Company at Queensboro, and the Ontario Sulphur Mines, Limited, at Tweed, were both engaged in opening up deposits of pyrite and made shipments of ore. The large bodies of pyrite at lake Minnetakie, near Superior Junction, which have been under development for several years by the Northern Pyrites Company, sent away none of their output last year, but will probably enter the market on a considerable scale in 1911. The geology of the neighborhood has been worked out by Dr. E. S. Moore.

The following table shows in brief form the development of iron pyrites mining in Ontario from 1906 to 1910:—

Table XI.—Production of Iron Pyrites, 1906 to 1910

Schedule.	1906.	1907.	1908.	1909.	1910.
Pyrites shipped ....tons	11,090	15,755	20,970	28,946	33,812
Value of do .... $	40,583	51,842	69,980	78,170	98,353
Workmen employed ....No.	128	137	132	132	227
Wages paid .... $	57,580	75,365	95,740	104,687	117,191

So far, it will be observed, the yearly wage-bill has exceeded the value of the output. This condition is due to the fact that some of the deposits, including the largest, have been continuously under development, and have not yet begun to ship in quantity. There are numerous bodies of pyrite in the Province, some of them extensive, upon which no mining has been done.[9] Want of railway communication is, doubtless, in part at least, the cause. The chief use of iron pyrites is, of course, in the production of sulphuric, nitric and "mixed" acids, for which purpose it has of late years replaced native sulphur where transportation charges gave it an advantage in the market. By "dead-roasting" the pyrite the cinder remaining after the sulphur is expelled can be used as iron ore.

Mica

The output of the amber mica mines of Ontario in 1910 was somewhat greater than in the previous year, being 513 tons of cobbed material, worth $85,294, as against 350 tons, worth $73,124 in 1909. Producers were Loughboro Mining Company, Sydenham; Kent Bros. and J. M. Stoness, Kingston: Scriven and Whyte, Sydenham; Kingston Feldspar and Mining Company, Kingston; Dominion Improvement and Development Company, Perth; J. W. Trousdale, Sydenham; W. L. McLaren, Perth; Rinaldo McConnell, Ottawa. The mica came wholly from the deposits of Lanark and Frontenac counties, which furnish a standard article and have been operated for many years. There is mica in other parts of the Province, notably the districts of Muskoka, Parry Sound and Nipissing, but little has yet been produced in a commercial way. The demand and consequently the prices for mica were better in 1910 than in the previous year.

Salt

The salt production of Ontario varies comparatively little from year to year. In 1910 the output was 84,071 tons, valued at $414,978, while in 1909 it was 77,490 tons, worth $389,573. The number of men employed in the industry was 202, and the amount paid as wages, $114,056.

The Canadian Salt Company, Limited, whose plants are at Windsor and Sandwich, is the chief producer of salt; others are Western Canada Flour Mills Company, Limited, Goderich; Dominion Salt Company, Limited, Sarnia, (this company took over the works of the Empire Salt Company and the Cleveland-Sarnia Saw Mills Company during the year); The Elarton Salt Works Company, Elarton; The Gray, Young and Sparling Company of Ontario, Limited, Wingham; The Western Salt Company, Limited, Mooretown; Ontario People's Salt and Soda Company, Limited, Kincardine; Parkhill Salt Company, Parkhill; Exeter Salt Works Company, Limited, Exeter; John Ransford, Stapleton.

The Pursuit of Potash

Many inquiries have been received at the Bureau of Mines regarding deposits of potash supposed to have been found in connection with salt wells at or near Goderich. These inquiries were prompted by a despatch which received wide publicity in the press, purporting to come from Berlin, Germany, and asserting that such deposits

[9] See, for instance, Bur. Min., Vol. XV. (1906), pp. 183-187, for description of deposits at Goudreau lake, Michipicoten district, "probably the largest known deposits of Ontario," by Dr. A. P. Coleman. Also "Iron Pyrites in Ontario," by E. L. Fraleck, Bur. Min., Ont., Vol. XVI., (1907), pp. 149-201.

had been located and a company formed to work them. Inquiry was made on the spot by Mr. C. W. Knight, Assistant Provincial Geologist, but it could not be found that there was any foundation whatever for the report, which may possibly have had its origin in the controversy that has for some time been on foot regarding the supply of potash from the German deposits to consumers in the United States.

There is no doubt that the discovery of potash salts in quantity would be a boon to the agricultural interests of Ontario, and indeed of the Dominion at large. Wood ashes, which in the early days of settlement when the forest was being cleared away and burned were plentiful and were largely made use of for the extraction of potash salts, are now no longer to be had in quantity, and our agriculturists are dependent for potash upon foreign sources of supply, which means Germany. There the potash deposits at Stassfurt are found in association with common salt, and no doubt the persons responsible for the report assumed that existence of salt at Goderich was a sufficient basis for diagnosing potash there as well. There is no evidence that such is the case. Indeed, there is evidence to the contrary. That eminent chemist and man of science, the late Dr. T. Sterry Hunt, made an examination of the salt wells at Goderich and especially of the diamond drill cores taken from the deep borings made by Mr. Attrill at that place many years ago. Dr. Hunt's report is published in the Report of the Geological Survey of Canada for 1876-7, and states that the cores were carefully tested for salts of magnesia and potash. In no case were any appreciable quantities found. Samples of salt of the pure white variety and also of the dark-colored, low-grade material, were taken by Mr. Knight and were analyzed by Mr. N. L. Turner, Provincial Assayer, who reported a trace of potash only in each sample. So far the result of inquiries has been negative. In the case of a brine from across the lake in Michigan, four analyses gave fairly concordant results, showing nearly 38 grammes of potassium chloride per litre, while the sodium chloride gave 197 grammes.

The Potash Deposits of Stassfurt

In view of the interest which the supposed potash deposits have created, and the importance of the German resources of this mineral, Mr. Knight has prepared the following brief description of the mines at Stassfurt:—

The potash mines are situated near the Harz mountains. Some are in the province of Hanover, some in Brunswick and some near the Thuringian forest. At first the deposits of rock salt only were utilized, the value of the other potash salts not being known. In 1857 a large bed of rock salt was penetrated at a depth of 1,080 feet, and overlying this bed was a layer of potassium and magnesium compounds. Four years later a process was perfected for extracting potassium chloride.

According to George Ryse (London *Mining Journal*, 19th January, 1907), the lowest stratum consists of the least soluble material, anhydrite ($CaSO_4$). The next above is rock salt interspersed with lamellar deposits of anhydrite which are gradually replaced by polyhalite, or sulphates of lime, potash and magnesia. Above this region, known as the polyhalite region, comes the kieserite region, in which, imbedded between rock salt, occurs kieserite or magnesium sulphate. Above this occurs the carnallite region, consisting of the chlorides of potash and magnesia. This stratum is 50 to 150 feet thick, and yields the most important of the crude potash salts from which is obtained the bulk of the refined product. Finally, strata of impervious salt-clay, anhydrite, and a remarkably pure deposit of rock salt are found, in the order named, and above all there are strata of gypsum, clay, sandstone and limestone which outcrop at the surface.

The deposits cover an area of about 100 square miles and in depth extend to probably 5,000 feet. Circular shafts, 18 to 20 feet in diameter, are sunk to levels 1,200 or 1,500 feet below the surface, and are lined either with concrete or iron tubing. Extreme caution must be exercised to prevent any inflow of water, and it is customary to have a reserve shaft at nearly all the mines. Another danger is from falling roofs, and all worked out portions of the mines are filled with waste and rock salt.

Of the various crude salts mined, by far the most important is carnallite. It occurs clear and transparent, or any shade of yellow, red, gray or black. These colors are due to impurities such as oxide of iron, clay, organic matter, etc. On account of its hygroscopic nature and its small percentage of potash, carnallite is used as a fertilizer only in localities which are not too far from the mines. Next to carnallite in import-

ance is kainite, the sulphates of potassium, magnesium and chloride of magnesium. It is too closely intermixed with rock salt to attempt separation, and consequently it is put on the market containing about 30 to 40 per cent. of rock salt. The last mineral of general importance is sylvite. It contains about 22 to 30 per cent KCl, 50 to 65 per cent. NaCl. and 4 to 12 per cent. K_2SO_4. It is richer in potash than kainite.

The primary material for all manufacturers is carnallite, having an average of 9 per cent. pure potash. The roughly ground carnallite (KCl, $MgCl_2$, 6 H_2O,) comes first into large dissolving vats, wherein it is treated with chloride of magnesia liquor, steam being passed through to aid dissolving. The chloride of potash, which is more soluble than sodium chloride in a saturated solution of magnesium chloride, is dissolved out, and a turbidity results. When the turbidity which is due to NaCl and $MgSO_4$ has settled, the solution is run into large iron crystallizing tanks, and allowed to cool for three or four days. It still contains from 25 to 40 per cent. NaCl. By evaporation and subsequent cooling of the mother liquor an artificial carnallite is obtained, which after being again dissolved in hot water, forms crystals of pure chloride of potash.

The chloride of potash from the crystallizations is ultimately washed with cold water, in order to remove the chloride of sodium and chloride of magnesium. After drying, the final product is a chloride of potash, 70 to 99 per cent. pure, according to the process adopted. The salts are then dried in ordinary furnaces or in calcining furnaces.

From kainite, by a somewhat complicated process, sulphate of potash and magnesia is obtained, in two forms, viz., crystallized with 40 per cent., and calcined with 48 per cent. sulphate of potash. The latter is used for fertilizing: the greater part of the former is utilized for the manufacture of sulphate of potash 90 to 96 per cent. pure. After producing the chloride of potash, there remains a mother liquor, consisting mainly of chloride of magnesium and 2 per cent. of bromine. From this solution the $MgCl_2$ is recovered by simple evaporation, and the bromine either by treatment with chloride or by the electrolytic method. About two-thirds of the total production of the chloride, one-eighth of the sulphate and the whole of the crystallized sulphate of potassium and magnesium are used for the manufacture of the various salts and compounds of potassium.

The salt beds of North Germany belong to the Permian, or on the border of the Diassic and Triassic formation. The beds lie at angles of 0 to 70 degrees at Stassfurt.

The deposition of the salt layers took place by the evaporation of salt water, with desert conditions prevailing. Interbedded with the salt beds are anhydrite, black shale, and bituminous limestone.

The carnallite region is a seam some 25 metres thick, extending over the whole salt deposits, and is the particular layer in which the potash salts are mined. The average composition of the carnallite deposits is 55 per cent. carnallite (KCl, MgCl, 6 H_2O) 26 per cent. rock salt, 17 per cent. kieserite ($MgSo_4$), 2 per cent. of other substances. Carnallite contains 26.7 per cent. KCl (Potassium chloride).

In boring at Unseburg, near Stassfurt, the rock salt underlying the potash-bearing salts was reached at a depth of only 80 metres, the lower layer being reached at 1,250 metres. Under these salt layers, anhydrite, black shale and bituminous limestone were bored through, and again at a depth of 1,280-1,290 metres rock salt was struck; at 1,295 metres boring ceased in gray anhydrite. The immensity of the rock salt deposit here may be realized from the fact that taken perpendicularly the measurement is 900 metres, the beds lying at an angle of 35 to 45 degrees.

A bountiful supply of potash is contained in the feldspar deposits at Verona and elsewhere on the line of the Kingston and Pembroke railway, this material containing as much as 13 or 14 per cent. of potash. The difficulty is that no feasible method has yet been discovered for converting the contained potash into soluble form. It has been stated that finely pulverized feldspar when applied directly to the ground will part with potash, though slowly, and thus act as a fertilizer. With the view of ascertaining the value of ground feldspar, a quantity from the deposits of the Kingston Feldspar and Mining Company has been forwarded to the Ontario Agricultural College at Guelph, where experiments will be conducted by the authorities of that institution.

Petroleum

The yield of petroleum again fell off markedly last year; indeed, the decrease in production which has been going on for a number of years has reduced the annual output to less than one-third that of 20 years ago. From the Department of Trade and Commerce, Ottawa, it is learned that the quantity of crude petroleum produced in

Ontario of which returns were made for purposes of the bounty amounting to $1\frac{1}{2}$ cents per gallon paid by the Dominion Government, was 11,004,357 Imperial gallons. Mr. W. J. Harvey, Supervisor of Crude Petroleum Bounties, Petrolea, kindly furnishes a statement of the output by districts, as follows:—

	Bbls. Gals.
Lambton	205,456— 1
Tilbury	63,057—21
Bothwell	36,998—19
Dutton	7,751—21
Onondaga (Brant Co.)	1,005— 3
Leamington	141—12
Total	314,410— 7

The falling-off has not been confined to any one field, but is general, though more noticeable in the newer Tilbury and Leamington districts than in the older Lambton field. The following comparative statement of production by districts shows how the diminution in yield has been going on during the last five years:—

Table XII.—Petroleum Production by Districts, 1906 to 1910

Field.	1906.	1907.	1908.	1909.	1910.
	bbl.	bbl.	bbl.	bbl.	bbl.
Lambton	377,286	304,212	265,368	243,123	205,456
Tilbury and Romney	106,992	411,588	201,283	121,003	63,058
Bothwell	44,827	42,727	39,228	38,092	36,999
Leamington	39,652	6,133	9,334	5,929	111
Dutton	19,376	14,977	13,743	9,513	7,752
Thamesville	175	237	....	....	....
Comber	651	....	....	....	....
Onondaga (Brant Co.)	....	....	....	....	1,005
Total	588,962	779,876	528,959	420,660	314,110

It will be seen that in the Lambton field the production fell off between 1906 and 1910 45.5 per cent.; in Tilbury-Romney the decline from the maximum output in 1907 was 84.6 per cent.; in Bothwell the drop from 1906 was 17.7 per cent.; in Leamington production has practically ceased, and in Dutton the decline was at the rate of 60 per cent. The only offset to this rapid decrease, which if continued will bring total exhaustion within sight, is the strike made last year in the township of Onondaga, near Brantford, where oil was found in the white Medina sandstone, the yield from two wells in 1909 being 1,005 barrels. A short description of this new oil field, by Mr. G. R. Mickle, Mine Assessor, is given below. The oil is of a superior quality, and brought a price of $1.29 per barrel at the close of the year. The average price for Petrolea crude during the year was $1.23 per barrel and for Tilbury, $1.06. On this basis, the value of the total crude production was $368,153.

The output of domestic crude being quite inadequate to meet the requirements of refiners, the deficiency is being made up by imports from the oil fields of the United States. The quantity of Canadian crude oil distilled in the refineries of the Province last year was 13,758,170 gallons, and of imported crude 17,227,262 gallons. In the following table are given details of the operations carried on by the oil-refining works, of which there are two, the Imperial Oil Company, Sarnia, and the Canadian Oil Companies, Limited, Petrolea:—

Table XIII.—Petroleum and Petroleum Products, 1906 to 1910

Schedule.		1906.	1907.	1908.	1909.	1910.
Crude produced	Imp. gal.	19,928,322	27,621,851	18,479,547	14,723,105	11,001,357
Crude distilled	"	36,134,349	34,961,706	34,675,120	35,530,918	36,171,032
Value crude produced	$	761,546	1,049,631	703,773	559,478	368,153
Value distilled products	"	2,506,177	2,568,464	2,347,680	2,501,384	2,511,368
Illuminating oil	Imp. gal.	16,125,450	18,319,233	17,604,920	17,902,254	18,983,357
Lubricating oil	"	4,351,818	3,931,767	3,384,940	3,856,778	4,469,038
Benzine and naphtha	"	3,497,954	4,132,239	3,667,997	3,930,691	4,297,615
Gas and fuel oils and tar	"	5,961,834	5,632,608	4,461,186	4,687,588	5,876,498
Paraffin wax and candles	lb.	5,011,467	5,132,394	5,400,003	7,092,278	5,179,391
Workmen employed	No.	496	435	430	436	428
Wages paid	$	308,986	265,316	247,829	261,014	280,485

Mr. John Scott, Inspector of oil and gas wells under 7 Edward VII., chapter 47, reports that during the year 1910 there were abandoned in the Petrolea field 194 oil wells, in the Tilbury field 148, in Raleigh 8, and in Romney 5, a total of 355 wells. In addition to the foregoing there are in the Petrolea district 649 oil wells from which the pumps have been removed (the wells not being abandoned) but which are being baled with fairly good results in many cases. No doubt some of these will be abandoned later. The repairing of defective oil wells and the proper plugging of abandoned ones have much improved the conditions in the fields of Lambton county. Many of the wells that remain are doing better and are more satisfactory in operation. No apparent benefit has been noted to the remaining wells in the Tilbury fields. There have been no important extensions to any of the various oil fields. The total production of crude oil has decreased, chiefly owing to the failure of the new fields at Tilbury and Romney, which appear to be about pumped out, and have to date proved very disappointing.

Mr. Scott's experience leads him to the conclusion that by taking good care of the wells, and regularly adding a few new ones, the production in the older fields may be maintained.

New Oil Field in Onondaga Township

Mr. Mickle's account of the Onondaga field is as follows:

This new oil territory, shown on the accompanying plan furnished by Mr. W. J. Aikens, of Dunnville, is situated in Onondaga township, county of Brant, about five miles from Brantford. Mr. Harold Howell, on whose farm oil was first proved to exist, states that the history leading up to this discovery was as follows:—Years ago small quantities of gas had been found and utilized locally. In 1909 two gas wells were drilled on the Van Sickle farm, south of the oil discovery. Encouraged by this a well was sunk in April, 1910, on the Howell farm, (part of lot 16 in the third concession east of Fairchild's creek), also shown on plan. Some gas was found, but it was not till late in the year that the presence of substantial quantities of oil was proved.

Productive Strata and Probable Importance

The oil is found in the White Medina at a depth of about 550 feet. The wells are drilled with a pocket 100 feet deeper. A small amount of gas is associated with the oil just sufficient to flow the oil in some of the wells for a few months. After this short period all the well owners find it necessary to instal pumps. The best well is said to have made 40 barrels per day for the first 20 days. The quality of the crude oil is good; the specific gravity is about .83. Not much can yet be said as to the probable productivity of the field, as there are no observations extending over more than a few days at any well. It appears that the wells will at the present time produce possibly five barrels or less per day each, but there is not the slightest clue yet as to how long that rate of production will be maintained. The oil is found over an area of 2 by 2½ miles, or 3 square miles. Provided the pore space is up to the average in productive fields, and the thickness of oil-bearing rock is not too small, and there is not an undue proportion of barren rock within the productive area, this area is capable of producing several million barrels of oil.

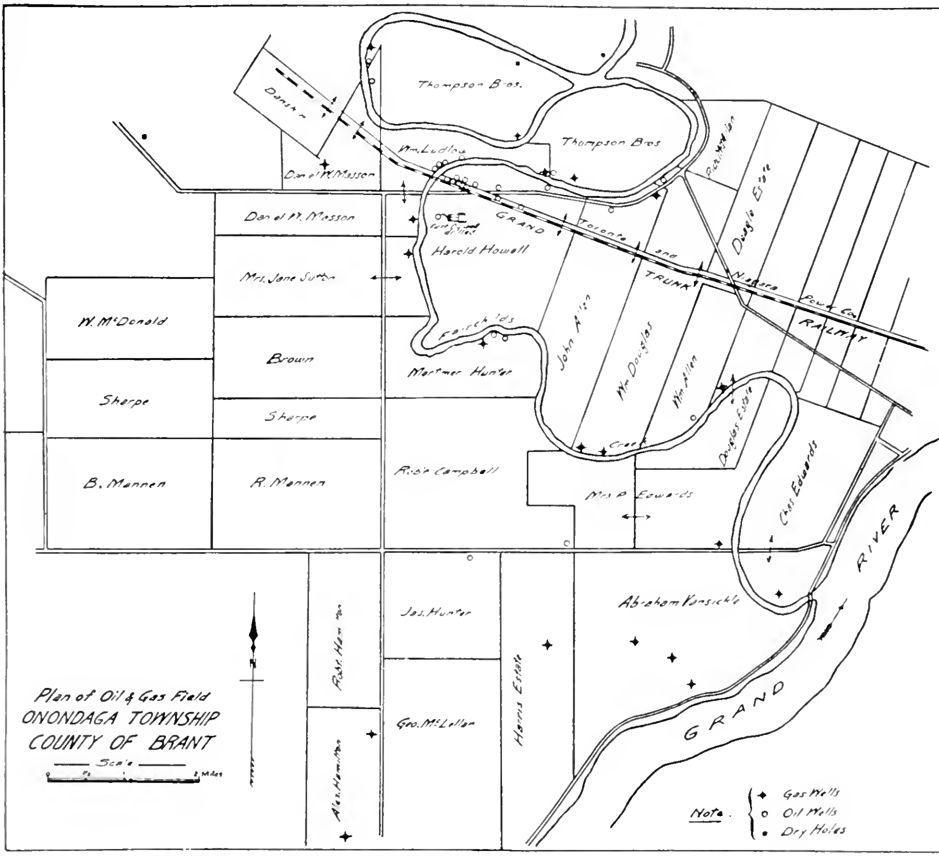
Extent of Operations

The wells are clustered round the Howell farm, on which six have already been drilled. The Mackenzie-Mann Company have drilled six wells on about 1,000 feet in

length of the right of way of the Niagara Power line which runs parallel to the Grand Trunk railway and immediately adjoining it. On the Ludlow farm to the east six wells have been sunk by Aikens & Carmody. About 30 wells in all have been drilled.

In the course of a few months from the present time (May, 1911) it will be known whether any substantial and important production may be expected from the Onondaga field. As the other oil territories in the province have shown a rapidly decreasing yield in the last few years, it will be a welcome addition to our oil resources.

Territory producing natural gas adjoins the oil to the south. The extent or probable value of this cannot be estimated at present.



Natural Gas

If petroleum is declining, natural gas is increasing, in production. In 1909 the output was valued at $1,188,179, while in 1910 it was $1,491,239, an increase of $303,060 or 25.5 per cent. The quantity of gas produced last year is given as 7,263,427 thousand cubic feet, so that the average price at which the yield is valued is 20.5 cents per thousand cubic feet.

The gas-producing territory of Ontario lies on the north and east shores of lake Erie. The several fields have been steadily extending, and appear likely to cover practically the whole of the Ontario side of the lake. At present, there are three separate fields, namely—Welland county, Haldimand and Norfolk counties, and Essex and Kent counties. The last-named was the largest producer in 1910, the Haldimand-Norfolk field next, and Welland county the smallest. Following are the figures pertaining to the natural gas business of 1910:—

Table XIV.—Natural Gas Production, 1910.

Field.	Producing wells. No.	Wells bored in year. Producing.	Wells bored in year. Non-producing	Miles of pipe.	Employees. No.	Wages paid. $	Gas produced. M cu. ft.	Value. $
Welland	337	33	8	401	67	40,411	1,047,463	278,756
Haldimand-Norfolk	444	103	21	400	71	43,315	2,374,730	676,986
Essex-Kent	47	9	1	181	48	35,059	3,841,234	535,497
Total	828	145	30	982	186	118,785	7,263,427	1,491,239

These figures show that the yield per well is very much greater in the Essex-Kent field than in any of the others, also that the price per thousand cubic feet obtained for the product in that field is considerably less than in either of the others, the average being Welland 26.6 cents, Haldimand-Norfolk 28.5 cents, Essex-Kent 13.9 cents. The consumption of gas in the Haldimand-Norfolk field is largely confined to domestic purposes, being piped to Hamilton, Dundas, Brantford, Galt and other places. The leading producer will sell only for household use.

Mr. Donald Sharpe, Welland, Inspector of wells under 7 Edward VII., chapter 47, whose sphere of operations lies principally in the gas fields of Welland and Haldimand-Norfolk, reports that the producing gas wells drilled in 1910 are distributed by counties as follows:—Haldimand 159, Welland 34, Brant 21, Norfolk 11, Wentworth 5 and Elgin 2. From new gas field at Middleport a new 4-inch main line has been laid across the Indian Reserve to the city of Brantford by the Standard Natural Gas Company. Two first-class wells have been drilled at Vienna and the prospects for the development of a new field here are particularly good for 1911. Drilling for oil will be actively prosecuted in the new oil field in Onondaga township, where two fair oil wells were brought in in 1910 and a third since the new year. All the larger gas companies are active in keeping their wells free from water and in good condition, but a state of affairs requiring special attention arises in cases where companies do not find gas in paying quantities and dispose of the wells to the owners of the premises on which they are situated, and who usually are without knowledge of the proper care of a well.

Mr. G. R. Mickle, Mine Assessor, the duties of whose office bring him into contact with the production of gas and oil, furnishes the following notes respecting developments in the natural gas industry during 1910, including a description of the new field in the township of Bayham:—

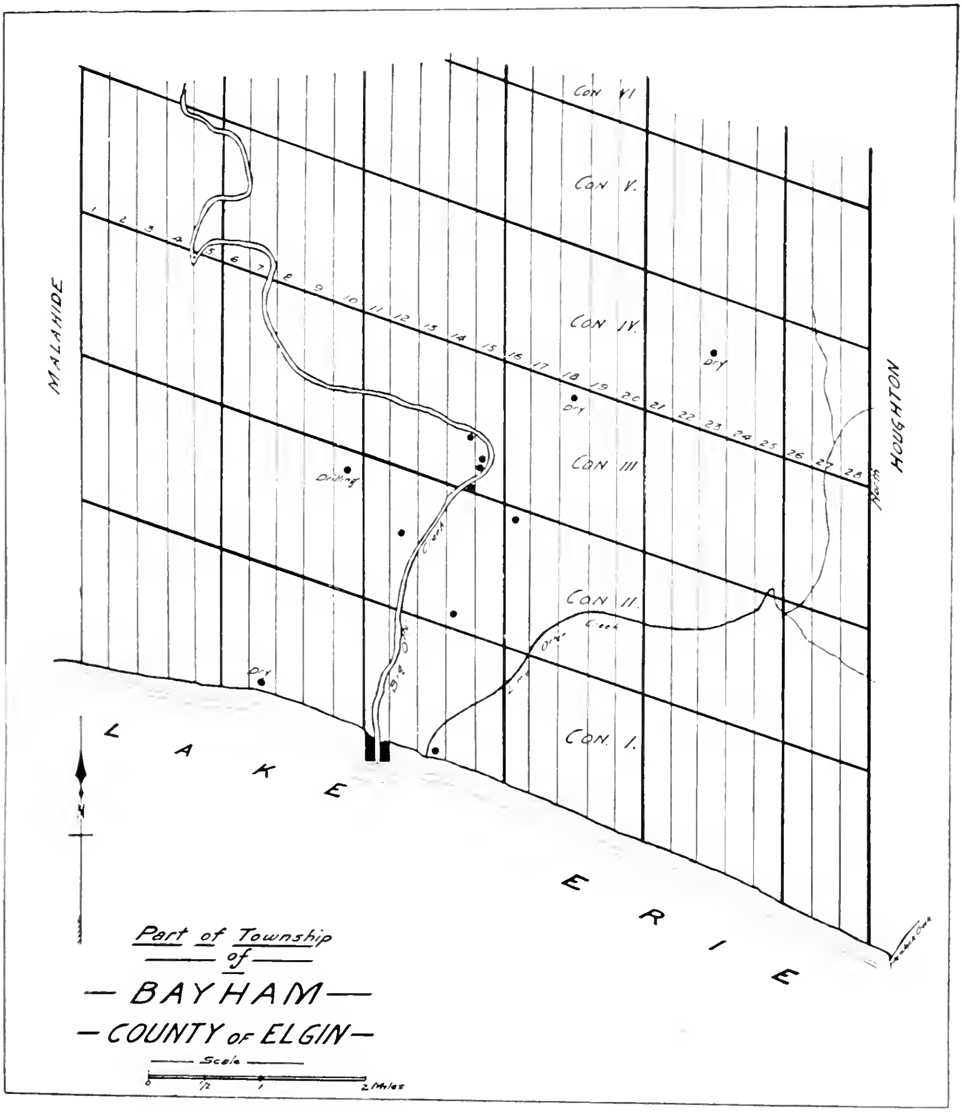
Developments in Natural Gas during the Year

In the past year the main features in connection with the natural gas industry in the Province have been the further development of the Welland-Haldimand-Norfolk field which may now be regarded as one, the discovery of a new productive area in Elgin county, and increased production from the Kent field.

In the first-mentioned field, which is the oldest and most extensive in area, stretching as it does along Lake Erie for about ninety miles and having a depth of probably two to three miles, the development has consisted principally in successful drilling in certain portions which have hitherto been regarded as unproductive or of little value. The field was also extended somewhat to the west. The drain from this territory has been very heavy; although the area is considerable, probably about 200 square miles, the thickness of the gas-bearing rock is usually small, and, in some of the most productive parts, the influence of the heavy production is shown by a very great drop in the rock pressure. The yield must therefore soon diminish. The wells in this field have a small average capacity, being substantially under 200,000 feet per well "open flow" measurement, or probably one-third or one-quarter that amount in actual delivery at the distant points of consumption. As a compensating advantage the depth is not great—about 800 feet—and consequently the expense of drilling is relatively small.

New Field in Elgin County

The newly found field in Elgin county is in the township of Bayham, as shown on attached plan. Only a few wells have been drilled up to April, 1911, and consequently no reliable estimate can be formed of the probable production from this field. As far as tested up to the present, (April, 1911), gas has been found at intervals over a territory of about one and a half miles frontage on the lake by a depth of about



three and a quarter miles, or an area of less than five square miles. Allowing for some extension under the lake, the tested area is probably between one-thirtieth and one-fortieth that of the Welland-Haldimand field and possibly one-sixth that of the Kent field. The thickness of the gas-bearing sand is very variable. As the productive area has not been fully delimited, and the average thickness is not known, and the pore space is, of course, indeterminable, no possible estimate can be made of the amount of gas. Practically no gas has been drawn off up to the present, consequently no information can be gained from the change in rock pressure.

The gas is found in the White Medina sandstone, which appears to be very porous here and favorable for holding large quantities of gas. The pay streak is found at a

depth of a little over 1,300 feet. The rock pressure is about 725 lb., or 48 atmospheres. In all the wells up to the present a heavy flow of water has been encountered at about 300 feet in depth. The amount flowing would probably fill a 3- or 4-inch pipe. A sample of the water tested in the physical laboratory of Toronto University showed the presence of slight traces of radioactive substances dissolved in the water, due, no doubt, to some salt of radium. The amount, however, was less than in the natural gas of Welland county or the petroleum of Lambton county. An analysis of the water showed a minute quantity of potassium, namely, .036 grammes per litre, also the presence of other substances, as follows:—

Sulphur	.203	grammes per litre.
Magnesia	.269	" " "
Lime	.283	" " "

The largest "open flow" measurement recorded at any of these wells is reported to be three million feet in 24 hours, and the smallest in the productive wells about a quarter of a million. In capacity, the wells in Elgin appear to lie intermediate between those of Haldimand and Kent, being greater than the former and smaller than the latter. The nearest towns of importance are Tillsonburg and Aylmer, about 15 miles distant.

Only two companies are operating in the Bayham field, viz.: The Dominion Natural Gas Company, which drilled the first well near the lake east of Port Burwell, and the Medina Natural Gas Company. Those controlling these companies have had long experience in the natural gas business. It is certain that in their hands the field will be energetically and intelligently exploited and that the gas supply will be well conserved.

Estimated Yield of Kent Gas Field

The Kent field was fully discussed in last year's report. No extensions have been made in the area, although the production of gas has increased rapidly. The minimum total ultimate production was given in that report as 61,000 million cubic feet with a probable yield of 90,000 million or more. Operations in the last year confirm the belief that the production may substantially exceed the estimate of probable yield given above.

Following are logs of three of the wells put down in the new Bayham field:

Log No. 1.

Well near Vienna, Bayham township; begun 5 October, 1910, finished 15 December, 1910. William Lauffer, contractor.

Formation	Thickness. ft.	Depth. ft.	Remarks.
Drift	193	193	
Black Shale	5	198	
Flint (very hard)	280	478	Strong flow sulphur water at 260 ft.; also some gas with sulphur water.
Lime (very hard)	447	925	Salt water at 725 ft., with small quantity gas. More salt water at 1,095 ft.
Niagara (very hard)	290	1,215	
Dark Shale (soft)	70	1,285	
Clinton	22	1,307	
White Medina	23	1,330	First gas 1,309 ft.
Red Medina (very soft)	45	1,375	

Log No. 2.

Well drilled on Drake farm, one-half mile east of Port Burwell, by the Dominion Natural Gas Company, Limited.

Formation.	Thickness. ft.	Depth. ft.	Remarks.
Drift	250	250	
Black shale	45	295	
Flint (very hard)	260	555	Heavy flow sulphur water at 300 ft., accompanied by very light showing of oil.
Limestone (very hard)	440	995	Salt water and some sulphur gas at 725 ft.
Niagara	280	1,275	More sulphur gas and small quantity salt water at 1,225 ft.
Dark shale	60	1,335	
Clinton	22	1,357	Big gas.
Red shale (mud)	15	1,372	
White limestone	20	1,392	
White Medina	5	1,397	

Log No. 3.

Wilkin's farm, south end lot 14, concession 2, Bayham township; begun 27 December, 1910, and finished 13 March, 1911. William Lauffer, contractor.

Formation.	Thickness. ft.	Depth. ft.	Remarks.
Drift	255	255	
Black slate	20	275	
Flint	50	325	First gas at 300 feet; sulphur water 320 feet.
Slate	25	350	
Lime	30	380	
Flint	300	680	
Lime	395	1,075	
Niagara	245	1,320	Salt water and sulphur gas at 1,080 ft.; small quantity salt water at 1,135 ft.
Slate	64	1,384	
Clinton	30	1,414	Big gas 1,398 ft.; showing of oil 1,414 ft.
Red shale	7	1,421	

Rock pressure, 745 lb.
Open flow of gas, 750,000 cubic feet.

Minor Products

Numerous mineral substances produced in Ontario not specially dealt with in the foregoing remarks, give rise to many industries of local importance, employing in the aggregate much labor and capital. Most of them are non-metalliferous in character, their production being given in Table I., page 6. Some of them are mentioned below.

Calcium Carbide

Calcium carbide, used in producing acetylene gas for lighting purposes, and made by the fusion of carbon and lime in the electric furnace, is turned out by two companies, the Willson Carbide Company at Merritton, and the Ottawa Carbide Company at Ottawa. Together, these companies produced and shipped 3,072 tons, valued at $184,323. They employed 56 men and paid out $37,630 in wages. The production in 1909 was 2,349 tons.

Corundum

For a number of years the production of corundum has been carried on by the Manufacturers Corundum Company, formerly the Canada Corundum Company, at Craigmont, and the Ashland Emery and Corundum Company at Burgess Mines. The Ashland Company's mines and works were leased by the Manufacturers Company, 1st August, 1910, and consequently passed into the hands of that company, which is at the present time the sole producer of corundum. The quantity taken out and shipped from both mines in 1910 was 1,870 tons of grain corundum, valued at $171,944, or about 4.59 cents per pound. There were 201 men employed at the mines and works, receiving in wages the sum of $100,945.

Feldspar

The production of feldspar went up from 11,001 tons in 1909 to 16,374 tons in 1910, the latter quantity having a value of $47,518. The labor of 107 employees was required, the amount of wages paid being $32,901.

The Kingston Feldspar and Mining Company, of Kingston, and the McDonald Feldspar Company, of Toronto, were the chief producers. The quarries worked by the former company are situated on lot 1 in the second concession of Bedford township, and on the southeast quarter of lot 16 in the eleventh concession of Portland township. The latter company operates a deposit near Verona. All are near the line of the Kingston and Pembroke railway, in Frontenac county. Besides feldspar, these deposits yield quartz or silica, practically pure, occurring in the form of dikes traversing the beds of feldspar. The quartz is used for such purposes as the manufacture of

ferro-silicon, while the feldspar is shipped to pottery trade centres in Ohio and New Jersey. As already mentioned, experiments are now being made at the Ontario Agricultural College, Guelph, with the view of determining the value of finely ground feldspar as a fertilizer. Containing, as they do up to 14 per cent. of potash, these Frontenac county deposits might prove very valuable in increasing the fertility of the farming lands of Ontario, should it be found that the soil has the property of dissolving the potash from the pulverized rock. It can scarcely be doubted that from feldspathic ingredients such as are contained in granite and gneiss, a large proportion of the potash now present in the soil was originally derived. The process of soil formation has, however, been age-long in its duration, and it is to be hoped that the assimilation of the potash in the pulverized feldspar, with its fertilizing virtues, will not be found in the Guelph experiments to demand so generous an expenditure of time, otherwise the benefit to the present and many succeeding generations will be but small.

Graphite

Refined graphite to the extent of 992 tons was produced last year from the mines and works of the Black Donald Graphite Company, Limited, at Whitefish lake, near Calabogie, in the county of Renfrew, and the Globe Refining Company, Limited, at Port Elmsley, in the county of Lanark. The value of the product was $55,637, the number of employees 70, and the amount paid out in wages $40,687. The Virginia Graphite Company are developing a graphite prospect on the south half of lot 35 in the fifteenth concession of the township of Monmouth, and propose to construct a mill having a capacity to treat 200 tons of ore per day. Mr. H. G. Tonkin, Wilberforce, is manager. The graphite occurs in a disseminated condition in limestone.

Gypsum

For many years gypsum has been raised in small quantities in the valley of the Grand river, but the industry has never attained large proportions. The mineral has hitherto been employed mainly in the manufacture of wall plaster, kalsomining preparations, wood fibre, bug poison, as a fertilizer for land, etc., but the development of the Portland cement industry has opened up a considerable outlet and has stimulated production. The admixture of a small proportion of gypsum has the effect of retarding the setting of the cement and so facilitating the manipulation of large quantities at a time. Recent explorations near Caledonia have revealed extensive gypsum deposits, and a new plant for hoisting, crushing and grinding the rock has been installed by The Alabastine Company of Paris. The Caledonia Gypsum Company has also erected a mill for grinding gypsum. This increased activity is not, however, shown in the statistics for 1910, since production on the larger scale did not begin until 1911. There were raised last year 10,043 tons of gypsum, having a value in the crude condition of $17,825. The number of employees was 52, and the payments in wages amounted to $5,062.

Quartz

The hoisting of quartz or silica for a variety of uses is rapidly increasing. Last year there were raised 90,685 tons, valued at $87,424 as against 63,172 tons, worth $75,329 in 1909. The number of men employed was 92 and wages were paid to the extent of $49,382. The nickel mining companies at Sudbury require a large part of the production for the lining of their furnaces. More or less quartz is obtained from the feldspar quarries along the line of the Kingston and Pembroke railway. A new deposit in the township of Conger, near Parry Sound, also shipped a considerable quantity to Welland for use in the electric smelting works at that place producing ferro-silicon.

Talc

Mr. George Gillespie, of Madoc, has established a good business at that place in the grinding of talc, which is raised from a deposit near by. A variety of grades are produced, and a ready market is found for them, not only in Canada,

but also in the United States and Europe, where the material is used in the manufacture of paper, soap, cosmetics, etc. The machinery used in reducing the talc and preparing it for market resembles that employed for the making of flour from wheat. The output in 1910 was 5,824 tons of prepared talc, valued at $46,592. In mining and milling 37 workmen were employed, to whom $15,252 was paid in wages.

Miscellaneous

The manufacture of peat fuel was carried on in 1910 at two places, one at the bog in Alfred township where the Mines Department of the Dominion Government has installed a plant on the Anrep system for making machine peat. The product was sold in Ottawa for domestic consumption, and was in good demand at $3.00 per ton. The other factory was in the township of Dorchester, where a small quantity of pressed fuel was prepared.

A little phosphate of lime was mined in 1910, but none was marketed.

Mr. Thomas Orgill, of Glen Orchard, has discovered diatomaceous earth, otherwise known as tripoli, in the district of Muskoka, in deposits believed to be of workable size and quality. This substance is useful for polishing purposes, and also in the manufacture of nitro-glycerine compounds.

The raising of actinolite was resumed in 1910, after an interruption lasting several years, but only a few tons were produced. Actinolite makes excellent roofing material.

A little fluor-spar was extracted from a deposit near Madoc, and a small quantity was shipped. It is largely used as a flux, and for the extraction of fluoric acid.

Tin was reported from a shaft sunk on indications of lead and zinc in the township of Fitzroy, but the genuineness of the discovery was not sustained by an examination made by the Bureau of Mines.

Mining Revenue

From mining sources the revenue for the year ending 31st October, 1910, was $941,030.09, as compared with $979,464.15 for the previous ten months. The items were as follows:—

1. On account of sales of mining land	$327,160 12
2. do leases do	29,008 79
3. Miners' licenses, permits and fees	193,682 48
4. Mining Royalties	246,529 13
5. Supplementary Revenue Act, 1907	143,209 59
6. Provincial mine	549 77
7. Provincial Assay office	890 21
Total	$941,030 09

Mining Lands

The receipts from sales of mining land include $284,517.08 from purchasers of locations in the Gillies timber limit, the remainder being from persons who, having performed all the work on their claims required by the Mining Act, proceeded to convert their title into a freehold by paying the price per acre demanded by the Act and obtaining a Crown patent. The price of mining lands is $2.50 and $3.00 per acre respectively, for locations in the unsurveyed and surveyed territory.

Mining leases are now only issued for lands included in a Forest Reserve, and a large part of the rental received last year was on account of lands leased for mining

purposes in the silver-bearing areas of Montreal River and Gowganda comprised within the boundaries of the Temagami Forest Reserve. The objection which used to be taken against the leasing provisions of the Mining Act, that capital could not be obtained on the security of a lease, is now seldom heard. The two mines in the Reserve producing silver most freely—the Millerett and the Miller Lake-O'Brien—are held under lease from the Crown. In the following table details are given showing the several districts in which are situated the lands sold or leased during the year. It may be observed that the totals do not agree with those given in the schedule above, the reason being that the figures represent the amounts received by the Department on account of the various transactions, whether paid within the year or previously, while the foregoing table has regard only to actual collections during the year.

Table XV.—Mining Lands Sold and Leased in Year Ending 31st October, 1910

District.	Sales.			Leases.			Total.		
	No.	Acres.	Amount.	No.	Acres.	Amount.	No.	Acres.	Amount.
			$			$			$
Nipissing	325	10,770.31	409,975.35	166	7,959.22	9,182.32	491	18,729.53	419,157.67
Sudbury	29	2,311.53	5,934.86	9	969.64	967.07	38	3,311.17	6,901.93
Thunder Bay	34	1,687.70	4,287.00	....	....	....	34	1,687.70	4,287.00
Algoma	27	1,933.52	3,748.32	....	....	....	27	1,933.52	3,748.32
Kenora	7	173.88	534.00	....	....	....	7	173.88	534.00
Elsewhere	8	369.00	852.00	1	100.00	100.00	9	469.00	952.00
Total	430	17,275.94	425,331.53	176	9,028.86	10,249.39	606	26,304.80	435,580.92

Receipts from sales in the Gillies limit constitute the greater part of the revenue from mining land. The figures would have been larger had not some of the highest bidders declined to proceed with their purchases, forfeiting the ten per cent. of their offers deposited along with their tenders. A balance may now be struck as follows as between receipts and expenditures on account of the Gillies limit lands:—

Receipts:—

Receipts from sale of locations		$492,045 14
Provincial Mine:—		
Sale of ore, etc.	$15,467 38	
Sale of mine	113,111 00	
		128,578 38
Total receipts		$620,623 52

Expenditure:—

Expenses, Provincial Mine and prospecting limit	$94,484 41
Surplus Receipts over Expenditure	$526,139 11

Miners' Licenses, Permits, and Fees

From the sale of miners' licenses and permits to search for minerals in Forest Reserves, and from fees paid on recording applications for mining claims, etc., the receipts amounted to $193,682.48. This item is strictly in the nature of current revenue, and rises or falls according to the degree of activity shown in prospecting for minerals and speculation in mining lands. The law requires the possession of a current miner's license before mining claims may be validly staked out or recorded, and also in a Forest Reserve a permit to prospect for minerals therein. The transfer of an unpatented mining claim cannot be registered by a Mining Recorder unless the transferee is the holder of a miner's license, and the non-renewal of a license by the recorded holder of a claim is regarded by the law as an abandonment of the claim. The fee for a miner's

license is $5, or if issued after the 1st of October, $3. All licenses expire on 31st March next after their issue. Incorporated companies pay for their licenses according to the amount of their capital stock. For a company whose stock does not exceed $40,000, the fee is $25; if over $40,000, but not exceeding $100,000, it is $50; if over $100,000 but not exceeding $500,000 the fee is $75; if over $500,000, but not exceeding $1,000,000, it is $100, and $100 additional for every additional $1,000,000 of capital, or fraction thereof. The fee for a permit to prospect in a Forest Reserve is $10, and the currency of the permit twelve months. The basis of the charge is the danger arising to the forest from the presence in it of a large number of prospectors, and the necessity of employing a staff of fire rangers to guard against the occurrence and spread of fires.

Mining Royalties

The mines paying a royalty on their output contributed a total of $246,529.13, as follows:—

O'Brien	$61,695 92
Crown Reserve	114,759 11
Hudson Bay	57,962 21
Chambers-Ferland	9,170 85
Hargrave	1,200 00
Waldman	777 48
Wyandoh	963 56
Total	$246,529 13

The O'Brien mine pays a royalty of 25 per cent. on the receipts from sales of ore, less one-fourth of the surface expenses; Crown Reserve, Waldman and Wyandoh, 10 per cent. on the value of the ore at the pit's mouth; Hudson Bay, 15 per cent. on the smelter returns; Chambers-Ferland and Hargrave, 25 per cent. on the profits estimated on the Supplementary Revenue Act basis.

The total amount received as mining royalties up to 31st October, 1910, was as follows:—

O'Brien mine	$536,053 44
Crown Reserve	289,454 42
Hudson Bay (formerly Temiskaming and Hudson Bay)	181,264 27
Chambers-Ferland	16,259 64
Hargrave	2,777 38
Waldman	777 48
Wyandoh	963 56
Total	$1,027,550 19

For the calendar year 1910 the accruals on account of royalties amounted to $342,958.76, all of which except $5,000 was paid within the year.

Supplementary Revenue Act, 1907

Under the provisions of the Supplementary Revenue Act, 1907, there was paid into the Department the sum of $143,209.59, as follows:—

Profit tax	$120,687 54
Natural gas tax	7,127 91
Acreage tax	15,394 14
Total	$143,209 59

The collection of the revenue arising under the above Act is entrusted to the Mine Assessor, Mr. G. R. Mickle, who furnishes the following memorandum, the figures in which, it will be observed, relate to the calendar year 1910, not the the fiscal year ending 31st October last:—

The Act imposes three different taxes, viz: (1) Profit tax, being leviable on the profits of mining companies in excess of $10,000, computed, as explained in the Act, at the rate of three per cent. Certain deductions are made for the municipal tax, if any. (2) Natural gas tax, being at the rate of two-tenths of a cent per thousand cubic feet or $2.00 per million on all gas used in Canada. (3) Acreage tax of two cents per acre on all patented or leased mining lands not situated in any municipality. The revenue collected under this Act for the calendar year 1910, amounted to $140,393.21, distributed as follows:—

Profit tax	$111,546 17
Natural gas tax	12,435 99
Acreage tax (April 15, 1910, to April 15th, 1911	16,411 05
Total	$140,393 21

This is about $39,000 in excess of the amount received the previous year and probably marks the limit. The increase in the total is due mainly to the profit tax, which was derived from eleven different companies, mostly in the Cobalt district. Several companies with a large output are under royalty agreements with the Crown whereby the tax when paid is deducted from the royalty. It is simpler to collect as royalty. If the tax were paid and deducted from the royalty, the amount accruing as profit tax would have been greater by about $48,000, and the royalties correspondingly less.

Some revenue seems assured in the future from the operation of mines other than silver or nickel. Gold, iron and pyrites should yield some returns. No substantial increase of the amount derived from profit tax is to be anticipated, however.

The natural gas tax was obtained from thirty-two different companies or producers, and is somewhat smaller than last year, due to the fact that although the actual production has increased, the amount exported or wasted, on which the tax is at a higher rate than on gas used in Canada, has been reduced to a very small amount, and before the end of the year 1909 (on which the tax is based) ceased altogether. Returns may be expected to show an increase for several years, owing to the heavier production from the Kent gas field and the opening of new territory in Elgin county.

The acreage tax was greater in 1910 than it has been in the past or will perhaps ever be again, as a considerable amount is due to back taxes collected before the 15th September, 1910, which was the last date fixed for payment of taxes on lands advertised as two years or more in arrears. The total number of acres thus advertised was about 247,000; of this 141,000 acres remained in arrears at the expiration of the time in which payment might be made and were consequently forfeited. This constitutes about 16 per cent. of the land which is taxable under the Act, and was contained in about 1,600 parcels. The percentage of area of taxable land thus forfeited is about the same in all the different districts, but the aggregate in the western part of the Province is much greater. This is due to the fact that most of the mining land in the western districts was granted before 1892 when the units of area were larger, and moreover not so many municipalities have been formed in that part, the land therefore remaining taxable by the Province, not by the municipalities.

In spite of the great mining activity in the northeastern part of Ontario the number of acres on the tax roll is not likely to increase. The land may be held three years without patenting and a very large percentage of the claims will be allowed to lapse. Moreover, wherever mining meets with success, municipalities will be formed and the power to tax will be transferred to the municipalities.

Mining Companies

In 1910 162 mining companies were incorporated under the laws of Ontario with an aggregate authorized capital of $128,999,300, as compared with 282 companies, having a capital of $236,883,000 in 1909. As will be seen by the list given below, the centre of company-making activity has been changed, and "Porcupine" is now the word to charm with, instead of "Cobalt."

Fourteen extra-Provincial corporations were granted license to carry on business in Ontario.

Table XVI.—Mining Companies Incorporated in 1910.

Name of Company.	Head Office.	Date of Incorporation.	Capital.
Aberdeen Ontario Syndicate, Limited	Toronto	Nov. 18, 1910	$20,000
Alice, Lorraine Mines, Limited	Haileybury	May 7, 1910	1,500,000
Amalgamated Porcupine Gold Mines, Limited	Toronto	Oct. 4, 1910	500,000
Atlas Mines, Limited	Toronto	Jan. 31, 1910	1,500,000
Big Creek Natural Gas Company, Limited	Hamilton	Jan. 6, 1910	200,000
Big Tooth Gold & Silver Mine, Limited	Toronto	July 20, 1910	40,000
Bobs Creek Mines, Limited	Toronto	Feby. 23, 1910	2,000,000
Bosancas Cobalt Mines Limited	Orillia	Feby. 5, 1910	1,000,000
Boston Development Company, Limited	Toronto	Dec. 6, 1910	100,000
Bradley-Donaldson Mines Limited	Ottawa	Sept. 13, 1910	1,000,000
Bremner Porcupine Mines, Limited	Toronto	Nov. 16, 1910	1,000,000
British North American Exploration Company, Limited	Toronto	April 16, 1910	200,000
Bull Dog Mining Company, Limited	Toronto	April 18, 1910	1,000,000
Canada Pebble Company, Limited	Port Arthur	Aug. 24, 1910	40,000
Canadian Porcupine Exploration Company, Limited	Toronto	Nov. 10, 1910	40,000
Canadian Sulphur Ore Company, Limited	Toronto	May 18, 1910	40,000
Church Lake Silver Mine, Limited	Hamilton	Mar. 10, 1910	1,100[illegible]
Cleveland Gow Ganda Mines, Limited	Toronto	Feby. 15, 1910	40,000
Crown Chartered Gold Mining Company of Porcupine Lake, Limited	Toronto	Feby. 11, 1910	2,000,000
Cyril Lake Mining Company, Limited	Toronto	Jan. 6, 1910	2,000,000
Development Company of Porcupine, Limited	Toronto	Dec. 2, 1910	1,000
Deville Mines Company, Limited	Toronto	April 7, 1910	2,000,000
Dobie Reeves Silver Mines, Limited	Toronto	July 15, 1910	500,000
European Process Peat Company, Limited	Toronto	Mar. 3, 1910	75,000
Gas Producer Company, Limited	Toronto	Aug. 2, 1910	1,000,000
Goldfields, Limited	Toronto	Mar. 14, 1910	3,000,000
Gray Porcupine Mining Company, Limited	Toronto	Oct. 3, 1910	40,000
Great North Mines, Limited	Toronto	Feby, 12, 1910	10,000
Great Western Cement & Gravel Company, Limited	Toronto	April 26, 1910	250,000
Halton Brick Company, Limited	Toronto	July 25, 1910	200,000
Harris Consolidated Mines, Limited	Toronto	Mar. 14, 1910	40,000
Harris Mines, Limited	Toronto	Jan. 4, 1910	2,600,000
Hecla Silver Mines, Limited	Toronto	June 8, 1910	200,000
Home Natural Gas Company, Limited	Hamilton	July 28, 1910	40,000
Homestake Mining Company, Limited	Gowganda	May 5, 1910	500 000
Hollinger Gold Mines, Limited	Toronto	June 28, 1910	3,000,000
H. R. 94, Limited	Windsor	May 2, 1910	40,000
Iris Mining Company, Limited	Windsor	Jan. 14, 1910	500,000
Jack Fish Mines, Limited	Toronto	Dec. 1, 1910	500,000
John Mann Brick Company, Limited	Brantford	Mar. 2, 1910	75,000
King Porcupine Mines, Limited	Toronto	Nov. 1, 1910	500,000
Lake Superior Silver Mines, Limited	Sault Ste Marie	Jan. 25, 1910	600,000
Lincoln Mines, Limited	Hamilton	May 17, 1910	300,000
Loon Lake Silver Mines, Limited	Haileybury	Sept. 29, 1910	1,000,000
Merger Mines, Limited	Toronto	Jan. 31, 1910	3,000,000
Miller Porcupine Gold Mines, Limited	Haileybury	Feby. 23, 1910	2,000,000
Mines and Stocks, Limited	Toronto	Dec. 9, 1909	10,000
Moneta Porcupine Mines, Limited	Toronto	Oct. 14, 1910	1,000,000
Monmouth Granite Quarries, Limited	Toronto	Mar. 5, 1910	50,000
Montreal and Porcupine Mining Company, Limited	Porcupine	Aug. 4, 1910	1,000,000
Montreal Tisdale Gold Mines, Limited	Sault Ste Marie	Dec. 31, 1910	2,000,000
National Gold Mines, Limited	Ottawa	April 5, 1910	1,500,000
North American Smelting Company, Limited	Kingston	Mar. 1, 1910	500,000
Northland Mining and Prospecting Company, Limited	Toronto	Mar. 22, 1910	100,000
North Shore Gas Company, Limited	Hamilton	Nov. 4, 1910	100,000
Ojaipee Silica-Feldspar, Limited	Toronto	Sept. 15, 1910	40,000
Old Glory Cobalt Silver Mining Company, Limited	Toronto	Jan. 4, 1910	500,000
Ontario Fidelity Mines, Limited	Toronto	Oct. 24, 1910	500,000
Ontario-Guibord Mining Company, Limited	Toronto	April 12, 1910	100,000
Ontario Iron Ores, Limited	Toronto	May 19, 1910	40,000
Ontario Northern Mines, Limited	Sault Ste Marie	Oct. 5, 1910	100,000
Pearl Lake Gold Mines, Limited	Haileybury	Oct. 28, 1910	2,500,000
Phœnix Consolidating Mining Company, Limited	Ottawa	April 29, 1910	1,000,000
Porcupine Bullion Company, Limited	Toronto	May 23, 1910	50,000
Porcupine Central Mining Company, Limited	Ottawa	Nov. 17, 1910	1,000,000
Porcupine Consolidated Mining Company, Limited	Toronto	Jan. 13, 1910	40,000
Porcupine Development Company, Limited	Haileybury	Feby. 15, 1910	100,000
Porcupine Exploration Syndicate, Limited	Toronto	Mar. 11, 1910	50,000
Porcupine Goldfields, Limited	Toronto	Jan. 5, 1910	500,000
Porcupine Gold Milling Company, Limited	Toronto	Dec. 6, 1910	500,000
Porcupine Gold Reef Mining Company, Limited	Toronto	Jan. 10, 1910	1,000,000
Porcupine Imperial Gold Mines, Limited	Toronto	Dec. 21, 1910	40,000
Porcupine Three Nations Gold Mining Company, Limited	Ottawa	Nov. 2, 1910	1,500,000
Porcupine Tisdale Mining Company, Limited	Cobalt	Feby. 11, 1910	2,000,000
Punxrutawney Mining and Development Company, Limited	Toronto	April 9, 1910	500,000
Purity Silver Mines, Limited	Toronto	Jan. 10, 1910	1,000,000
Quigley's Mines, Limited	Toronto	April 23, 1910	200,000
Rea Mines, Limited	Toronto	Nov. 11, 1910	40,000
Reliance, Limited	Toronto	Feby. 8, 1910	40,000
Ridgley Porcupine Mines, Limited	Toronto	May 25, 1910	500,000
Royal Westmount Mines, Limited	Elk City	June 25, 1910	2,000,000

Table XVI —Continued

Name of Company.	Head Office.	Date of Incorporation.	Capital.
[illegible] Limited	Toronto	Mar. 31, 1910	2,500,000
Schumacher Brick and Tile Company, Limited	Toronto	Mar. 18, 1910	100,000
Silver Country Mines Consolidated, Limited	Toronto	Mar. 2, 1910	2,000,000
Silver Dollar Mining Company, Limited	Owen Sound	April 15, 1910	1,000,000
Silver Nugget Mines, Limited	Haileybury	Jan. 12, 1910	1,000,000
Sociate Mines, Limited	Toronto	Dec. 23, 1910	150,000
South Tisdale Gold Mining Company, Limited	Toronto	Oct. 28, 1910	3,000,000
Standard Gold Mines, Limited	Haileybury	Mar. 18, 1910	1,500,000
Standard Natural Gas Company, Limited	Brantford	Oct. 7, 1910	50,000
Stewart Mines, Limited	Toronto	July, 19, 1910	1,000,000
Strand Mining Company, Limited	Toronto	Mar. 3, 1910	1,000,000
Superior Mining Company, Limited	Ottawa	Nov. 24, 1910	20,000
Suroff Feldspar Mining and Milling Company, Limited	Toronto	Mar. 8, 1910	150,000
The A 91 Mining Company, Limited	Toronto	Mar. 18, 1910	33,300
The Auerbach Mining Company, Limited	Haileybury	May 2, 1910	2,500,000
The Bannock Lake Mining Company, Limited	Sudbury	Mar. 17, 1910	500,000
The Bannerman Mining Syndicate, Limited	Haileybury	Sept. 7, 1910	100,000
The Black Prince Graphite Mining Company, Limited	Ottawa	Oct. 26, 1910	50,000
The Boreal Mining Company, Limited	Toronto	Aug. 4, 1910	100,000
The Brantford Mining Company, Limited	Brantford	Jan. 12, 1910	500,000
The Canada Slate Company, Limited	Toronto	Jan. 27, 1910	500,000
The Canadian Consolidated Mining, Lumber and Utilities Company, Limited	Toronto	April 30, 1910	4,000,000
The Canadian Calcium Carbide, Limited	Niagara Falls	Mar. 5, 1910	600,000
The Carrie Handcock Mining and Development Company, Limited	Kenora	May 4, 1910	100,000
The Central Porcupine Gold Mines, Limited	Toronto	Sept. 12, 1910	1,000,000
The Chelmsford Coal, Gas and Oil Company, Limited	Chelmsford	Aug. 31, 1910	500,000
The Cobalt Frontenac Mining Company, Limited	Hamilton	Nov. 20, 1910	2,000,000
The Dome Mines Company, Limited	Toronto	Mar. 23, 1910	2,500,000
The Dominion Salt Company, Limited	Sarnia	April 12, 1910	100,000
The Dominion Zinc and Mineral Mining Company, Limited	London	April 4, 1910	300,000
The Dorchester Peat Company, Limited	London	Aug. 29, 1910	75,000
The Dudhope Mining and Milling Company, Limited	Hastings	Mar. 15, 1910	500,000
The East Dome Syndicate, Limited	Toronto	Nov. 23, 1910	1,000,000
The Enterprise Gas Company, Limited	Delhi	May 3, 1910	100,000
The Golden Horse Shoe Mining Company, Limited	Toronto	May 23, 1910	2,000,000
The Great Eastern Porcupine Gold Mines, Limited	Ottawa	June 10, 1910	1,000,000
The Haliburton Gold Mining Company, Limited	Windsor	Nov. 1, 1910	1,000,000
The Island Smelting and Refining Company, Limited	Toronto	April 22, 1910	3,000,000
The Kenora Mines, Limited	Kenora	June 20, 1910	500,000
The Lakeview Mining Company of Cobalt, Limited	Cobalt	Sept. 22, 1910	1,000,000
The Legris Silver Mines, Limited	Toronto	July 13, 1910	1,500,000
The Leroy Lake Syndicate, Limited	Haileybury	Mar. 12, 1910	1,000,000
The Lone Pine Gold Mining and Milling Company, Limited	Dryden	Aug. 11, 1910	300,000
The Lucky Volunteer Gold Mining Company, Limited	Toronto	Nov. 30, 1910	100,000
The Manufacturers' Natural Gas Company, Limited	Hamilton	Feby. 24, 1910	1,000,000
The Maple Camp Mining Company, Limited	Sault Ste Marie	Jan. 22, 1910	75,000
The Marathon Silver Mine, Limited	Haileybury	Mar. 12, 1910	1,500,000
The M. & H. mining and Development Company, Limited	Ottawa	Feby. 8, 1910	500,000
The Metropolitan Cobalt Mining Company, Limited	Haileybury	July 29, 1910	2,500 000
The Millcrest Mining Company, Limited	Toronto	May 19, 1910	1,000,000
The Menes Mines, Limited	Sault Ste Marie	Nov. 29, 1910	3,000,000
The Nipigon Hermatite Ore Company, Limited	Nipigon	Jan. 13, 1910	1,000,000
The Nipissing Extension Mining Company, Limited	Toronto	April 22, 1910	500,000
The Ontario Lorrain Mining Company, Limited	Toronto	Jan. 12, 1910	1,000,000
The Opportune Oil and Land Company, Limited	Petrolia	Mar. 8, 1910	50,000
The Ox Bow Mining Company, Limited	Haileybury	June 13, 1910	2,500,000
The Pergola Sulphur Mining Company, Limited	Hamilton	Oct. 14, 1910	400,000
The Pinder Exploration Company, Limited	Toronto	Feby. 7, 1910	100,000
The Producers Natural Gas Company, Limited	Hamilton	Oct. 7, 1910	200,000
The Quartz Lake Silver Mining Company, Limited	Haileybury	Feby. 8, 1910	500,000
The Rockwood Lime and Stone Company, Limited	Rockwood	June 6, 1910	40,000
The Roscoe Mining Company, Limited	Toronto	Aug. 30, 1910	100,000
The Ross Ballard Mines, Limited	Renfrew	Jan. 12, 1910	1,000,000
The Ryan Gillies Silver Mining Company, Limited	Cobalt	Mar. 23, 1910	1,750,000
The Standard Brick Company, Limited	Toronto	May, 4, 1910	25,000
The Steelton Brick and Tile Company, Limited	Sault Ste Marie	July 12, 1910	100,000
The Success Gold Mines Company, Limited	Porcupine	Oct. 3, 1910	900,000
The Tiflin Oil and Gas Company, Limited	Havelock	April 11, 1910	50,000
The United Counties Oil and Gas Company, Limited	Sarnia	Mar. 27, 1910	40,000
The Vermilion River Gold Dredging Company, Limited	Toronto	Aug. 11, 1910	1,000,000
The Vipond Porcupine Mines, Limited	Toronto	Mar. 29, 1910	50,000
The Wellandport Natural Gas Company, Limited	Wellandport	June 9, 1910	10,000
Tisdale Central Mines of Porcupine, Limited	Toronto	Dec. 14, 1910	40,000
Tisdale Gold Mining Company, Limited	Toronto	Oct. 1, 1910	500,000
United Nickel-Cobalt Company, Limited	Sudbury	Sept. 28, 1910	40,000
United Porcupine Gold Mines, Limited	Toronto	Feby. 10, 1910	1,500,000
Valentine Mines, Limited	Ottawa	Mar. 29, 1910	1,500,000
Veteran Gold Mining Company, Limited	Toronto	Feby. 14, 1910	250,000
Welch Mines, Limited	Toronto	May, 18, 1910	1,000,000
Wentworth Gas Company, Limited	Hamilton	Nov. 29, 1910	500,000
Willet Cobalt Mining Company, Limited	Toronto	Dec. 1, 1909	2,000,000
Total Authorized Capital			$128,999,300

Table XVII.—Mining Companies Licensed in 1910.

Name of Company.	Head Office.	Date of License.	Capital.
Benson Cobalt Smelting and Refining Company, Limited	Toronto	Sept. 27, 1910	$40,000
Canadian Oil Producing and Refining Company, Limited	Toronto	July 29, 1910	£75,000
Duncan Lake Mining Company	Toronto	Feby. 24, 1910	$100,000
London and Gowganda Exploration Company, Limited	Toronto	April 8, 1910	£200,000
National Paving and Contracting Company	Port Arthur	July 15, 1910	$100,000
Russell Shale Brick Company, Limited	Russell	Sept. 5, 1910	....
Scottish Ontario Gold Mining Syndicate, Limited	Toronto	Mar. 23, 1910	£5,000
Standard Oil Company of Canada	Toronto	Sept. 5, 1910	£60,000
La Compagnie Miniere de la Vallee du St. Maurice, Limited	Cobalt	April 7, 1910	$250,000
The British American Oil Company, Limited	Toronto	Dec. 27, 1910	....
The Columbian Oil and Gas Company of Canada, Limited	Toronto	July 15, 1910	....
The Pacific Coast Exploration Company, Limited	Toronto	May, 31, 1910	....
The Powerful Mining Company	Latchford	April 7, 1910	75,000
United Cobalt Exploration Company	Guelph	May 31, 1910	1,000

Mining Divisions

The only change in the Mining Divisions in 1910 was the creation of a new Division at Porcupine to accommodate the prospectors who began staking claims in the gold area there during the autumn of 1909. Parts of the Temiskaming, Sudbury and Montreal River Mining Divisions were combined to form the Porcupine Division, the date of the Order in Council creating the same being 27th January, 1910. Early in 1911 it became evident that the convenience of the mining community along the line of the T. & N. O. railway near the height of land would be better met by an office on the railway which would be within reach of prospectors on both sides of the line, than by the office at Larder lake, situated in the southeastern portion of the territory. Consequently the Larder Lake Division was considerably enlarged by adding to it a portion of the Temiskaming Division, and the Recorder's office was removed to Matheson. The date of the Order in Council making these changes was 13th March, 1911. Following is a description of the tract added to the old limits of the Larder Lake Division:

Commencing at the northeast angle of the Township of Otto, on the Temiskaming and Northern Ontario Railway in the District of Nipissing; thence west astronomically along the north limit of said township and along the north limit of the Township of Eby, 12 miles to Ontario Land Surveyor, T. B. Speight's, meridian line as run in 1902; thence north astronomically along said meridian line 18 miles to the southeast angle of the Township of Playfair; thence west astronomically along the south boundary of said township and along the south boundary of the Townships of McCann, Egan, and Sheraton 24½ miles more or less to the southwest angle of the latter; thence north astronomically along the west boundary of the Townships of Sheraton, Bond and Stock, 18 miles, to the southeast angle of the Township of Dundonald; thence west astronomically along the south boundary of the Township of Dundonald 6 miles to the southwest angle thereof; thence north astronomically along the west boundary thereof 6 miles to the northwest angle thereof; thence east astronomically along the north boundary of the Townships of Dundonald, Clergue, Walker, Wilkie, Coulson, Warden and Milligan 42½ miles more or less to the northeast angle of the latter; thence north astronomically ten chains more or less to the south shore of Lower Abitibi Lake; thence northeasterly easterly and southerly along the south shore of said Lower Abitibi Lake and along the west shore of Biederman's Narrows to Upper Abitibi Lake; thence easterly, northeasterly and southeasterly along the north shore of said Upper Abitibi Lake to the Interprovincial boundary between the Provinces of Ontario and Quebec; thence south astronomically along said Interprovincial boundary 22 miles more or less to Ontario Land Surveyor, J. J. Newman's, base line as run in 1907, which base line intersects the Interprovincial boundary as a point 27 chains 53 links north of the 61st mile post thereon measured north from Lake Temiskaming; thence west astronomically along said base line 22¾ miles more or less to the northeast angle

of the Township of Barnet; thence south astronomically along the east boundary of said township 6 miles to the southeast angle thereof; thence west astronomically along the south boundary of said township 24 chains 88 links to Ontario Land Surveyor, J. J. Newman's, meridian line as run in 1907; thence south astronomically along said meridian line 18 miles more or less to the place of beginning. Saving and excepting therefrom the Abitibi Indian Reserve containing 20 square miles more or less lying to the east of the Townships of Milligan and McCool: said territory including the surveyed Townships of Dundonald, Clergue, Walker, Wilkie, Coulson, Warden, Milligan, McCool, Munro, Beatty, Carr, Taylor, Stock, Bond, Currie, Bowman, Hislop, Guibord, Michaud, Barnet, Cook, Playfair, McCann, Egan, Sheraton, Benoit and Maisonville.

The Recorder's office at Cobalt having served the purpose for which it was established, and the mining lands in the original Cobalt area being practically all taken up and a large proportion of them patented, an Order in Council was passed on the 10th January, 1911, attaching the special Mining Division of the township of Coleman to the Temiskaming Mining Division, and removing the head office to Haileybury, where it was placed in charge of Mr. George T. Smith, the Recorder for the Temiskaming Division. The change took effect 1st February, 1911.

Following is a list of the Mining Divisions with the name and post-office address of the Recorders and a statement of the moneys taken in at the various offices during the year ending 31st October, 1910:—

Table XVIII.—List of Mining Divisions, 1910.

Mining Division.	Name and P.O. Address of Recorder.	Receipts.			Total receipts.
		Purchase money.	Miners' licenses.	Recording fees, etc.	
		$	$	$	$
Kenora	W. L. Spry, Kenora	1,412 26	838 00	1,287 25	3,537 51
Port Arthur	J. W. Morgan, Port Arthur	4,250 25	1,966 25	4,712 60	10,929 10
Sault Ste. Marie	S. T. Bowker, Sault Ste. Marie	4,538 55	1,849 00	1,995 00	8,382 55
Sudbury	C. A. Campbell, Sudbury	1,443 39	4,016 00	16,189 50	21,648 89
Montreal River	A. Skill, Elk Lake	5,540 58	4,525 00	6,338 25	16,403 83
Gowganda	H. E. Sheppard, Gowganda	736 03	3,468 00	11,308 42	15,512 45
Temiskaming	G. T. Smith, Haileybury	13,834 60	20,278 60	40,300 25	74,413 45
Larder Lake	J. A. Hough, Matheson	4,402 12	663 00	1,399 00	6,464 12
Parry Sound	H. F. McQuire, Parry Sound	400 00	447 00	348 00	1,195 00
Porcupine	A. E. D. Bruce, Porcupine	2,755 50	4,160 00	17,548 92	24,464 42
Coleman	G. T. Smith, Haileybury	3,382 01	8,852 00	1,889 00	14,123 01
	Totals	42,695 29	51,062 85	103,316 19	197,074 33

For those portions of the Province not included in any Mining Division having a local Recorder's office, the Deputy Minister of Mines acts as Recorder at the Department, Toronto. Here there were received during the fiscal year on account of purchase money $294,714.22, for miners' licenses $32,996.64, and for recording fees $6,306.80.

The several Mining Recorders report shortly on the business of their offices for the year ending 31st December, 1910, in the following terms:—

Kenora

During the year there were issued from this office 105 miner's licenses, 74 renewal licenses, 89 certificates of work, 27 certificates of record; 91 mining claims and 4 quarry claims were recorded; 83 transfers were registered, 2 working permits issued, 2 disputes filed and disposed of, and 17 applications for mining patents received and dealt with.

The actual business of the year has been light, yet much office work was necessary. From a mining standpoint the district has been inactive, but with the opening up of the Mikado gold mine and several others in the district, and the throwing open of dozens of mining claims that have been tied up for years, interest will, no doubt, be revived. Recorder, W. L. Spry.

Port Arthur

During the year ending December 31st, 1910, 211 miner's licenses and 320 renewals of licenses were issued, and 207 mining claims recorded.

Seventeen applications from Rainy River district were received in this office, and together with the recording fee of $170.00 were forwarded to the Bureau of Mines; 21 applications for claims in Sault Ste. Marie mining division, together with the recording fees, were forwarded to the Recorder at Sault Ste. Marie; and 16 applications for claims in the Kenora division were received and forwarded to the Recorder at Kenora, together with the necessary fees.

The excitement caused by discoveries of rich gold-bearing veins in the region of Sturgeon lake has somewhat abated, but still considerable prospecting is being carried on and a number of rich lodes have recently been discovered.

There have been no discoveries of much importance in new territory, but a large amount of development work has been performed. Several disputes have been settled during the year. Recorder J. W. Morgan.

Sault Ste. Marie

Miner's licenses issued, 142; renewals, 234; mining claims recorded, 181. Recorder, S. T. Bowker.

Sudbury

In the year 1910 miner's licenses issued numbered 409, renewals, 404; mining claims recorded 1,131; there were 67 applications for boring permits.

This is a falling off of 728 claims in comparison with last year. The reason for this is the opening of the Porcupine Mining Division, which took away the territory from the Sudbury Division. Also the discovery of gold in that region has diminished the interest in silver. In the region along the Wahnapitae river in the Reserve, which last year was quite active, there has been very little staking, although many of those who have previously staked do not seem to have lost confidence, and are keeping up their assessment work fairly well.

The new features this year are the staking of iron on the Mattagami river near Grand Rapids. Some more iron ore has lately been staked in the township of Olrig, in Hugel township a number of gold claims, and some iron in Berth 10.

Staking for gold has lately begun to the south and southwest of Porcupine Mining Division, some in the Temagami Reserve and some outside. Recorder, C. A. Campbell.

Montreal River

Miner's licenses issued 247, renewals, 518; mining claims recorded, 344; certificates of record granted 133, ditto work 193.

The work of developing the mining land of the Montreal River Mining Division has not been carried on with the same energy that marked the period of 1909, but those remaining in the district are still of the opinion that it will eventually produce a large quantity of valuable mineral. The counter attractions provided in the Porcupine camp have joined with the operations of unscrupulous speculators in producing the depression which usually follows a mining boom. The stringency of the money market and the hesitancy of capital to invest in mining ventures has confined the work of development in this Division to an area which is considerably smaller than the one worked a year ago, but the optimists who have remained secured very gratifying results during the past summer. The section around Hubert lake and the township of Willet may be particularly mentioned in this connection. The finds on the Currie properties at Hubert lake, the showing on the Clawson and the Mapes-Johnson at Silver lake, and the satisfactory results of the work on the Tee Arr Mining Company's property make that district look very desirable. Financial difficulties have occasioned the discontinuance of work on the Gavin-Hamilton, Mother Lode, Royal Westmount and Lucky-Godfrey claims, but most of the others in this vicinity are preparing

to carry on extensive operations during the coming year. This, coupled with the development of the new finds that have been made in Willet, James and Tudhope should enable investors to arrive at a satisfactory estimate of the value of the district during the coming summer. Recorder, Albert Skill.

Gowganda

The following is a report of the work done by this office during the year ending the 31st December, 1910:—

Licenses issued, 200; licenses renewed, 477; certificates of record issued, 147; certificates of performance of work issued, 255; claims recorded, 513. Recorder, H. E. Sheppard.

Temiskaming

The amount of business transacted in the Temiskaming Mining Division for the fiscal year ending 31st October, 1910, has been satisfactory. Between the 1st November and 31st December, 1909, 399 miner's licenses were issued; 18 miner's licenses renewed, and 1,021 applications for mining claims recorded. From 1st January to 31st October, 1910, 1,275 licenses were issued; 2,053 licenses renewed, and 2,028 applications for mining claims recorded, forming a total of 1,674 licenses issued, 2,071 licenses renewed, and 3,049 applications for mining claims recorded during the twelve months.

Discoveries reported from widely intervening points show that the boundaries of the recognized mineral area are constantly extending, and the coming season is likely to be a record one.

Development work all over the Division has been very actively carried on, and the results on the whole have been gratifying. While the Porcupine gold fields have to a great extent overshadowed all other mining camps in this section, the idea prevails—and recent occurrences go to strengthen it—that Porcupine has not a monopoly of the precious metal. Beatty, Bryce, Munro and Otto all seem to have something above mere pretensions to becoming gold camps, and the country west of Holmes is also an aspirant for similar honors.

Some promising discoveries have been made in the South Lorrain and Metabitchewan districts, and while the Wettlaufer is the only steady shipper, it is said that ere long other properties will likely be included in the list. Extensive development work was carried on on the Lang-Caswell properties in Lorrain, and while no ore has been shipped, things are said to look very promising.

The Green-Meehan mine in Bucke has renewed operations, and a couple of other properties adjacent to North Cobalt, which for some time have been dormant, will likely resume operations shortly. Recorder, Geo. T. Smith.

Larder Lake

The business transacted in this office during 1910 comprised 84 applications, 58 transfers, 1 agreement, 65 certificates of record, 73 certificates of performances of working conditions, 1 dispute, 4 appeals to Mining Commissioner, two transfers of mining partnership shares, 90 renewal licenses, 21 miner's licenses, 2 substituted licenses; 58 claims were purchased. Recorder, J. Atwell Hough.

Parry Sound

[illegible] claims were recorded during the year, for gold, copper, feldspar, silica, mica [illegible] lot 4, concession 9, Conger, some shipments of silica have been made to [illegible] Hamilton. Samples of mica shown from the townships of Ferguson and [illegible] are very promising. Little or no effort has been made to open these deposits [illegible] of lack of transportation. Iron properties in the township of Lount are [illegible] by American parties. Recorder, H. F. McQuire.

Porcupine

Six hundred and fifty-nine miner's licenses and 420 renewals were issued in 1910, a number of transfers, agreements, etc., were recorded; also 2,150 applications for mining claims. Recorder, Arthur E. D. Bruce.

Coleman

In 1910 609 miner's licenses and 977 renewals were issued; 40 claims were recorded. Recorder, T. A. McArthur.

Diamond Drills

For several years the Department maintained two diamond drills which were placed at the disposal of persons who wished to explore mining lands or mineral deposits by boring. It having become apparent that there were now in private hands a sufficient number of drills to serve all such requirements, both the drills were disposed of, and the Department is no longer in a position to undertake work of this kind.

Provincial Assay Office

The following report on the work of the office for 1910 is submitted by Mr. N. L. Turner, Provincial Assayer:—

The Provincial Assay Office was established in July, 1898, by the Ontario Government as an aid to the mineral development of the Province. The office has rendered many services for the public, as is shown by the large number of assays and analyses made. The rates are sufficiently low to allow prospectors and others to have their finds examined at small cost. The office is well fitted with assay and analytical apparatus for the testing of the various ores and minerals which are distributed so widely throughout the Province.

The past year has been a busy one in this office, a large number of samples having been received from all parts of Canada and various parts of the United States. During the summer numerous samples of limestone were received from Quebec. These were examined as to their suitability for the manufacture of cement. A number of similar samples were also received from Newfoundland.

There appears to be a renewed interest in the northern part of Hastings county, judging from the numerous inquiries which were received for information regarding deposits of mica, feldspar, fluorite, etc., in that part of the Province. Probably the greatest need here is good transportation facilities.

As usual, a large number of samples were received from the Cobalt, Porcupine and Sudbury districts.

During the year 1,138 samples were assayed and analyzed in whole or part and reports as to commercial value issued. The total fees collected and transmitted to the Provincial Treasurer amounted to the sum of $1,265.84, and the value of the work performed for the Bureau of Mines amounted to $899.25 (this figure only includes the actual value in assays of samples), making a total of $2,165.09.

The work for the public consisted of:—

(*a*) Issuing reports consisting of assays, analyses, and identification of samples submitted.

(*b*) Supplying information, where possible, to owners of mineral land who desired to know of probable purchasers, and also advising as to uses, value, etc., of their minerals.

The work for the Bureau of Mines consisted of:—

(*a*) Sampling and assaying of car lots of cobalt-silver ore from the several Cobalt mines paying royalty to the Crown, shipped to the various reduction works.

(*b*) Sampling and analysing of shipments of cobalt oxide from the different smelters on which the Government grants a bounty.

(*c*) Analyses and assays of various samples submitted by members of the Government geological staff.

(*d*) Rock analyses of samples sent in by the Provincial Geologist and members of his staff.

Instructions as to Samples

The following instructions are for the benefit of those who desire to send in samples for examination—

Crushed samples, representing the average of large quantities or samples less than 5 lbs. in weight, may be sent by mail as 3rd class matter (two cents for the 1st four ounces or fraction thereof, and one cent for each additional two ounces.) Write your own name and address plainly on the parcel and send instructions with money in payment of fees in a separate letter. When more than one sample is sent at one time, each sample must be distinctly marked or numbered, so that they may be identified by instructions in letter. Samples may be sent per express, charges prepaid.

Sample bags addressed to this laboratory for sending ore pulp by mail may be obtained free on application, also canvas bags for shipping ore.

Each determination made in the laboratory is checked off by a duplicate when sufficient material is sent, thus reducing errors to a minimum. The pulp of each sample is retained for future reference, subject to order of sender.

Money in payment of fees sent by registered letter, Post Office Order, Postal Note, Express Order, etc., must invariably accompany samples in order to insure prompt return of certificates, which are not sent till fees are paid in full.

Price List for Assays

Gold and silver ores.	For 1 Sample.	For 3 to 5 samples at one time each.	For 6 or more samples at one time each.
Gold, by fire method	$1 00	$0 90	$0 75
Silver, by fire method	1 00	0 90	0 75
Gold and silver	1 25	1 00	0 90
Gold by amalgamation assay for free gold	2 00	1 80	1 50

For amalgamation assay of a gold ore at least 5 lbs. of ore must be sent.

The following tests are recommended along with amalgamation assay: Fire assay of the ore to see how results obtained check off with the amalgamation assay: panning down of ore to obtain concentrates: and fire assay of the concentrates, also fire assay of tailings.

The laboratory is also prepared to do cyanide assays on raw ore, tailings, concentrates, etc., with amalgamation tests and fire assays where needed. Not more than 50 lbs. of ore can be treated.

The Laboratory makes a specialty of Check Assay Work on gold ores. Samples sent in for check assays must be crushed to at least 5 or 10 mesh, especially in the case of gold ores variable in richness. At least 12 ounces of pulp must be sent for assay. A sample consisting of a single piece of ore, however large, is practically of little value in testing a deposit, and in no case suitable for check assay. Two pieces of gold ore taken from the same spot in a deposit will not necessarily give the same values on assay. The amalgamation assay for gold with fire assay of concentrates and tailings is recommended for gold ores, either in the rough or pulped, containing coarse free gold, as the fire assay alone will give variable results.

The most satisfactory method of checking results is to mix ore pulp and divide the pulp into two equal parts, sending the separate lots to this Laboratory with different marks.

	1 sample.	3 to 5 samples.	6 or more samples.
Miscellaneous assays:—			
Copper by fire assay method	$1 25	$1 00	$0 90
Copper by cyanide method	1 25	1 00	90
Copper by electrolytic method	1 25	1 00	90
Lead by titration method	1 25	1 00	90

	1 sample.	3 to 5 samples.	6 or more samples.
Zinc by titration method	2 00	1 80	1 50
Nickel by electrolytic method	3 00	2 70	2 25
Platinum by fire assay method	2 00	1 80	1 50
Cobalt by electrolytic method	3 00	2 70	2 25
Arsenic by titration method	2 00	1 80	1 50
Manganese by titration method	3 00	2 70	2 25
Chromium by titration method	3 00	2 70	2 25
Antimony by titration method	2 00	1 80	1 50
Bismuth by titration method	2 00	1 80	1 50
Iron (metallic) by titration method	50	45	30
Molybdenum by titration method	2 00	1 80	1 50
Tin fire assay by titration method	2 00	1 80	1 55

A reduction of 15 per cent. on the total is allowed on 6 or more assays on one sample and 20 per cent. on 10 or more assays on one sample.

Fees for Qualitative Examination. Not equivalent to an assay or analytical determination, only showing the presence or absence of certain constituents, no values or percentages given.

Iron	$0 25	Platinum	$1 00
Copper	25	Arsenic	50
Nickel	1 00	Bismuth	50
Cobalt	1 00	Molybdenum	50
Zinc	50	Lime	50
Lead	50	Magnesia	50
Chromium	1 00	Alumina	50
Manganese	1 00		

Complete qualitative examination of any sample, $8.00; other constituents at same rates.

Identification of mineral samples, that is, determination of the constituents that may be determined by inspection, field tests, blow pipe or rough qualitative examination, is done by the Laboratory at a nominal charge of 50 cents per sample; three or more samples at one time 40 cents each.

This also includes a report as to the probable commercial value of the sample.

Samples for identification must be sent in a rough state, *i.e.*, not pulverized. Samples for identification will be reported on free of charge if brought to the laboratory by parties desiring such reports.

Price List or Analytical Determinations

Iron Ores.	For 1 Sample.	For 3 to 5 samples at one time each.	For 6 or more samples at one time each.
Silica	$1 00	$0 90	$0 75
Alumina	1 00	90	75
Ferric oxide	1 00	90	75
Ferrous oxide	1 00	90	75
Lime	1 50	1 35	1 10
Magnesia	1 50	1 35	1 10
Sulphur	1 50	1 35	1 35
Phosphorus	2 00	1 80	1 50
Titanium	2 00	1 80	1 50
Manganese	1 50	1 35	1 10
Metallic iron	50	45	35
Moisture	25	20	15

Other determinations same as in iron and steel.

15 per cent. discount from total for 6 or more different determinations on one sample; 20 per cent. discount for 10 or more on one sample.

Pig iron, steel, cast iron, wrought iron, etc.:—			
Silicon	$1 00	$0 90	$0 75
Sulphur	1 50	1 35	1 10
Phosphorus	2 00	1 80	1 50
Arsenic	2 00	1 80	1 50

Manganese	1 50	1 35	1 10
Graphitic carbon	1 50	1 35	1 10
Combined carbon	1 50	1 35	1 10
Carbon by combustion	1 50	1 35	1 10
Carbon by color	1 00	90	75
Nickel	3 00	2 70	2 20
Cobalt	3 00	2 70	2 20
Chromium	3 00	2 70	2 20
Tungsten	3 00	2 70	2 20
Titanium	2 00	1 80	1 50
Vanadium	6 00	5 40	4 40
Copper	1 25	1 00	90

15 per cent. discount from total for 6 or more different determinations on one sample 20 per cent. discount for 10 or more determinations on one sample.

Limestones, clays, marls, cements, etc., etc.:—

	For 1 Sample.	For 3 to 5 samples at one time each.	For 6 or more samples at one time each.
Silica—free	$1 00	$0 90	$0 75
Silica—combined as in clay	1 00	90	75
Ferric oxide	1 00	90	75
Ferrous oxide	1 00	90	75
Alumina—combined	1 00	90	75
Alumina—free as corundum or bauxite	1 00	90	75
Lime	1 50	1 35	1 10
Magnesia	1 50	1 25	1 10
Alkalis—soda and potash	1 50	1 25	1 10
Carbonic acid	1 00	90	75
Organic matter	1 00	90	75
Sulphuric acid	1 50	1 35	1 10
Moisture	25	20	15

NOTE:—Complete analysis of a sample is always preferable, as it includes a report on the quality and commercial value of the sample, also the industrial uses to which the material may be put. Reductions on several determinations on one sample as in iron ores.

Coals, cokes, peat, lignite, etc.:—

Moisture	$0 25	$0 20	$0 15
Volatile combustibles	1 00	90	75
Fixed carbon	1 00	90	75
Ash	1 00	90	75
Sulphur	1 50	1 35	1 10
Phosphorus	2 00	1 80	1 50
Analyses of ash, same rates as in rocks, Calorimeter tests of heating value (British Thermal units)	6 00	5 40	4 50

Ultimate analyses:—

Carbon, Hydrogen, Nitrogen, Oxygen, Ash, etc., special rates on application.

MINING ACCIDENTS

BY E. T. CORKILL, Chief Inspector of Mines

During the year 1910 at the mines regulated by the Mining Act of Ontario there were 46 fatal accidents, causing the death of 48 men, being a decrease of one as compared with the previous year. Of the fatalities 29 occurred below ground and 19 above ground. The total number of serious accidents in the mines of Ontario reported to the Bureau of Mines was 107, resulting in 48 men killed and 67 injured. Of these accidents 69 occurred below ground and 38 above ground. The fatal accidents took place at mines operated by 34 different companies.

Analysis of Fatalities

The 46 fatal accidents took place in the following months:—

January, 3; February, 2; March, 1; April, 2; May, 5; June, 5; July, 1; August, 6; September, 6; October, 4; November, 6; December, 5; total 46.

An investigation and report were made in 41 of the 46 fatal accidents that occurred during the year. In addition, the more serious non-fatal accidents were investigated and reported on.

The following table shows the number of men and their nationality killed at the different classes of work:

Occupation.	English speaking.	Italian.	Finlander.	French.	Polander.	Austrian.	Swedish.	Russian.	German.	Norwegian.	Indian.	Total.
Surface laborer	1	5			2				1			9
Machine helper	1		2	1		1						8
Machine driller	3		3	1								7
Mucker	3			1		1		1			1	7
Hand Miner							1			1		2
Foreman	1	1			1							3
Manager	1											1
Scaler	1											1
Trackman		1										1
Pumpman	1											1
Block holer					1							1
Electrician	1											1
Student	1											1
Ore sorter	1											1
Top-hoistman (blast furnaces)	1											1
Brakeman	1											1
Painter				1								1
Repair man	1											1
Total	21	7	5	1	1	2	1	1	1	1	1	48

Of the 48 fatalities in 1910, 14.6 per cent. resulted from falls of ground; 16.6 per cent. from shaft accidents; 20.8 per cent. from explosives; 8.4 per cent. from miscellaneous causes underground and 39.6 per cent. from accidents on the surface.

Cause and Place of Fatalities

The following schedule shows the cause and place of the fatalities in 1910 compared with 1909:

		1910.	1909.
Below ground:			
Falls of ground		7	5
Shaft accidents:—			
Falling from bucket	1		
Falling down shaft	2		
Cage accidents	2		
Riding on skip contrary to law	1		
Objects falling down shaft	2		
	—	8	10

Accidents from explosives:—			
Premature explosion while loading or lighting holes....	4		
Picking or putting bar into old hole containing explosive.	2		
Drilling into bottom of old hole	2		
Picking into explosive in muck	2		
	—	10	17
Miscellaneous accidents:—			
Falling down winzes	3		
Struck by rail used in replacing car..................	1		
	—	4	4
Above ground:			
Surface fatalities:—			
Slip of ore in blast furnace	2		
Smelter, miscellaneous	5		
Asphyxiated by gases at top of blast furnace	1		
Fall from trestle or framework	2		
Thrown from car	1		
Electrocuted	3		
Struck by cage while looking down shaft...............	1		
Run over by railway car	1		
Cave-in of trench	1		
Struck by falling shear-leg..........................	1		
Fall from ladder	1		
	—	19	13
		—	—
Total		48	49

Classifying the accidents according to degree of responsibility attached to the contributing causes, the following distribution is obtained:—

1. Accidents due to danger inherent to the work itself .... 10 or 21.7 per cent.
2. Accidents arising out of defect in mine workings ...... 10 or 21.7 do.
3. Accidents through fault of fellow workmen .... 4 or 8.7 do.
4. Accidents through fault of injured person .... 21 or 45.7 do.
5. Accidents impossible to classify .... 1 or 2.2 do

The following table summarizes the fatalities in the mines of Ontario from 1900 to 1910 inclusive, with reference to the number of persons employed:—

Table showing Fatal Accidents in Mines of Ontario, 1900 to 1910

	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	Total.
Persons killed in producing and non-producing mines	17	13	10	7	7	9	11	22	47	49	48	240
Persons employed in producing mines..	3,330	4,135	4,426	3,499	3,475	4,415	5,017	6,305	7,135	8,505	10,862	61,304
Persons employed in non-producing mines (estimated).................	650	550	450	400	400	500	750	1,140	1,750	2,000	2,000	10,590
Total persons employed	3,980	4,685	4,876	3,899	3,875	4,915	5,767	7,345	9,185	10,505	12,862	71,894
Fatal accidents per 1,000 employed	4.27	2.77	2.05	1.79	1.80	1.83	1.90	2.99	5.11	4.66	3 73	3.33

Cause and Place of Non-Fatal Accidents

The following schedule shows the cause and place of the non-fatal accidents in 1910, and the number injured:—

Underground:		
Falls of ground		5
Shaft Accidents:—		
R.ding in bucket contrary to Act	1	
Cage accidents	6	
Objects falling down shaft	1	
Falling down shaft	2	
	—	10
Explosives:—		
Premature explosion	5	
Picking or putting bar into old hole	2	
Drilling into bottom of old hole	1	
Picking into explosives in muck	2	
	—	10
Miscellaneous accidents:—		
Falling down stopes, raises, winzes or man-ways	6	
Jammed by cars or bucket	8	
Scaling	1	
Miscellaneous	7	
	—	22
Surface:—		
Caught by machinery	7	
Explosives	1	
Falling material	4	
Jammed by cars	3	
Miscellaneous	5	
	—	20
		—
Total		67

Mining Regulations and How Observed

The regulations regarding the operation of mines in the Province were fairly well observed during the year. The more important regulations, regarding the timbering of shafts, stopes, etc., are better observed than the so-called less important rules, such as those requiring protection of shaft openings and machinery by guard rails. Mining companies in the initial stage of development work on their properties are often more negligent than after the mines have begun production. The matters in which negligence is most often shown are as follows:—

1. The erection and maintenance of approved thawing houses.
2. Guards for shaft openings
3. Guards for dangerous machinery.
4. Leaving loose powder in underground workings.
5. Maintaining auxiliary ladders in the shaft while sinking.
6. Reporting of careless practices by the workmen.
7. Drilling and picking into old bottoms of holes that have been blasted.
8. Guarding and proper insulation of electric wires and apparatus.

Carelessness in regard to the above has resulted in many serious and fatal accidents. One of the first essentials in starting to develop a mine is to provide a suitable magazine and approved thawing house. The failure to do so generally results in the

deterioration of the explosive, and creates the dangers involved in thawing and handling improperly prepared material. A number of the other rules violated are referred to in another part of the report in connection with accidents that have resulted from such violation.

The following notes describe briefly the fatal accidents from the several causes, and methods that should be adopted for their prevention.

Falls of Ground

There were 7 fatal accidents from this cause, resulting in the death of 7 men. This was an increase of 2 over 1909. Of these 7 fatalities, 2 resulted while the men were actually engaged in scaling and were struck by the rock they had loosened. These accidents were evidently the result of carelessness or incompetence on the part of the men killed. If caused by incompetence, then the company were at fault for putting unskilled men at the important work of scaling, where only skilled miners should be employed. Three men were killed by being struck by rock falling from the wall or roof of the stope at which they were working. The onus for these accidents must be placed on the companies. The Mining Act requires the roofs and walls of all working places to be inspected and scaled once every week, and a record kept thereof. It is, however, necessary that the walls, in proximity to ground that is blasted, should be inspected and scaled after every blast. It is essential that some of the bosses should look over this ground and see that the machine men or scalers have left it in a safe condition. Miners are naturally careless and take too much for granted about the condition of the walls and roof. In our copper-nickel, iron and other low-grade ore mines the stopes are large, and it is good practice, and one that is adopted by a number of the companies, to have men whose sole duty is to scale, constantly going over the walls and roofs to see that they are safe.

One man was killed by a piece of rock in which he was drilling in the roof of a drift, falling on him. Such accidents are rare, since the danger can be at once detected by the sound of the drill working on the rock. It is to be feared that incompetency is a heavy factor in causing our large fatality list.

Shaft Accidents

There was a further reduction of fatalities from shaft accidents, there being 8 men killed in 1910 compared with 10 killed in 1909. One marked improvement was in cage accidents, there being but 2 men killed from this cause in 1910, compared with 5 in 1909. One of these men was killed by attempting to ring the bell while the cage was in motion. The other man was apparently seized by a fainting or dizzy spell while riding alone on the cage, and falling to the floor was caught in the timber. The only prevention for accidents of this nature is to have cages that are used for hoisting or lowering men completely cased in. The following is a description of cage recommended by the committee appointed by the American Mining Congress to draft a uniform mining law for prevention of mine accidents:

The hood shall be of two steel plates 3-16 inch in thickness, sloping toward each side, and so arranged that they may be readily pushed upward to afford egress to persons therein; and such bonnet must cover the top of the cage in such a manner as to protect those on the cage from objects falling in the shaft. The cage shall be provided with sheet-iron or steel side casing, not less than 1-8 inch thick, or with a netting composed of wire not less than 1-8 inch in diameter, and with doors made of the same material as the side casing, either hung on hinges or working in slides. These doors shall extend at least 4 feet above the bottom of the cage and must be closed when lowering or hoisting men, except timbermen riding on the cage to attend to timbers that are being lowered or hoisted. Every cage must have overhead bars of such arrangement as to give every man on the cage an easy and secure handhold.

This type of cage would eliminate accidents such as occurred this year. It would be advisable for mine managers installing new cages to have them built according to the above specifications.

Two men were killed through falling down the shaft while working part way down. In one case the man was repairing timber and standing on a ladder fastened by a rope to the top rung, when the rung broke, allowing him to fall to the bottom. In the other case a pump-man was repairing the pump on the landing at a level, when he stepped backwards into the unguarded shaft opening. The company in the latter case was prosecuted by the Inspector of Mines before the Police Magistrate of Cobalt, for violation of the law in not having guard rails, and was fined $100 and costs.

Two men were killed by being struck by objects falling down the shaft, caused by using defective gearing. One was struck by a bucket falling, owing to the breaking of an eye-bolt in the horse-whim, and another was struck by a falling machine which was being hoisted in a rope sling, due to the breaking of the rope. This emphasizes the necessity of a daily inspection by a competent official of all gearing, as required by the Mining Act.

One man was killed by falling from a bucket while being hoisted away from a blast, and another through riding up on a skip. The former slipped while getting on the bucket and held on with his hands, his partner not having presence of mind enough to stop the bucket at once and help him in. Many miners apparently get nervous when lighting fuse in a shaft. The manager should never allow men of this class to light fuse in a shaft or winze, as accidents are sure to happen sooner or later. The other man was stealing a ride on the skip, and apparently attempted to get out before the surface landing was reached, so that he would not be caught by the boss, and was run down by the skip. It is absolutely necessary for superintendents or shift bosses to report to the Inspector of Mines whenever they find a man riding on the bucket or skip contrary to law, so that the man can be prosecuted. If a man knows he will be fined from $10 to $100, if caught, he will hesitate before taking the chance. I consider this the most effective way of stopping this practice, and would ask that all cases be reported.

Safety Crossheads

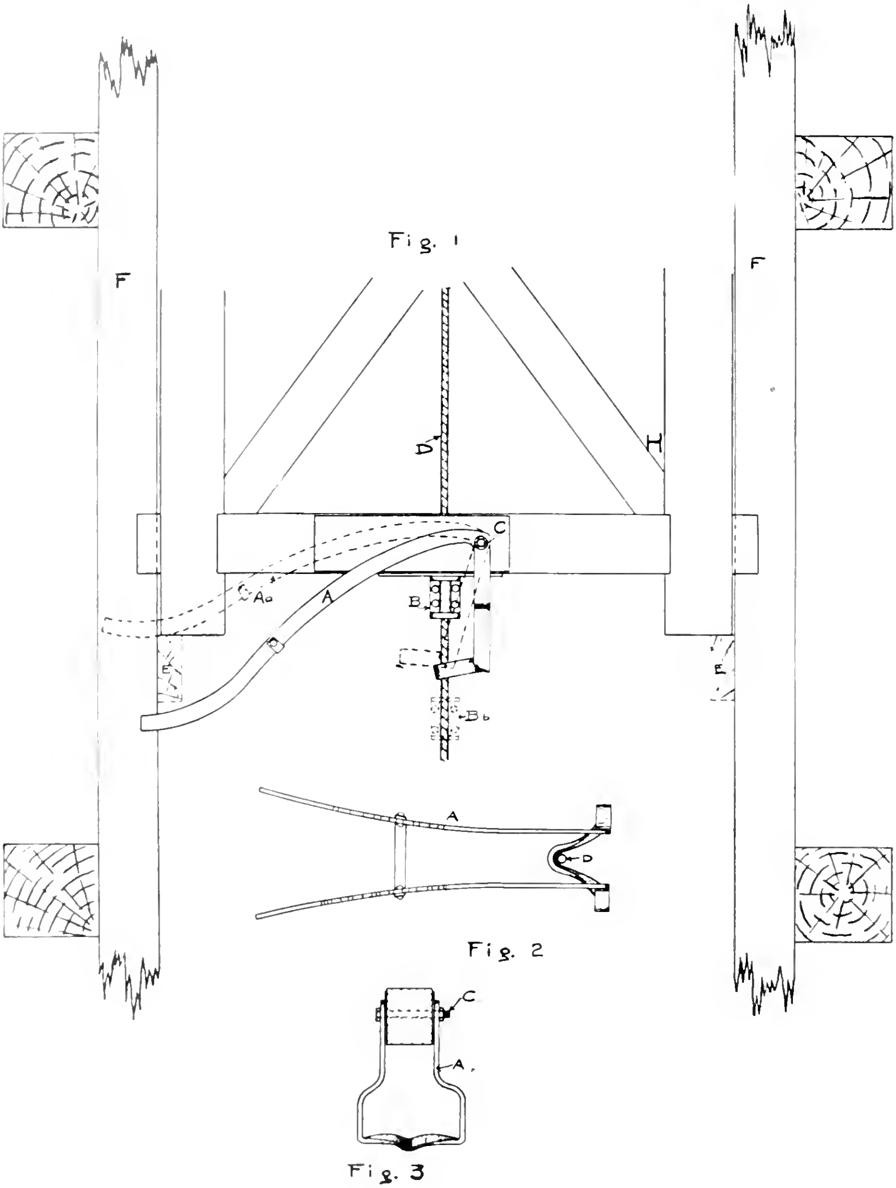
It has been shown in former Reports of the Bureau of Mines that a number of accidents are caused through the falling of crossheads in shafts. To overcome this difficulty, two crossheads have been patented by Messrs. Morin and Sargeson, master mechanics at the Nipissing and Waldman mines. The idea of these patents is to keep the crosshead from falling when it sticks in the shaft. In the Sargeson patent, which is shown in the accompanying cut, the attachment A is fastened to the crosshead at C. If the crosshead sticks, this arm automatically engages the clip B attached to the cable, and so stops the bucket. In sinking operations the arm A is automatically tripped by the stopblock E, allowing the bucket to descend to the bottom of the shaft.

The same principle is adopted in the Morin crosshead in the bucket follower, shown in the accompanying cut. It is further equipped with an automatic safety device, which by the aid of springs enables dogs to grip the guides, thus making it impossible for the crosshead to fall.

Accidents from Explosives

Ten men lost their lives through explosive accidents underground in 1910, and none on the surface. This is a marked improvement over 1909, when 49 per cent. of the total fatalities were caused by explosions or gases from explosions, compared with 20.8 per cent. in 1910. Four of these fatalities were the result of contravention of the Mining Act by the employees who were killed, in picking or drilling into old bottoms of holes that had been blasted. An employee of the City of Cobalt mine was prosecuted in July, 1910, before the Police Magistrate at Cobalt for a violation of section 164, rule 9, of the Mining Act of Ontario, and fined $10 and costs.

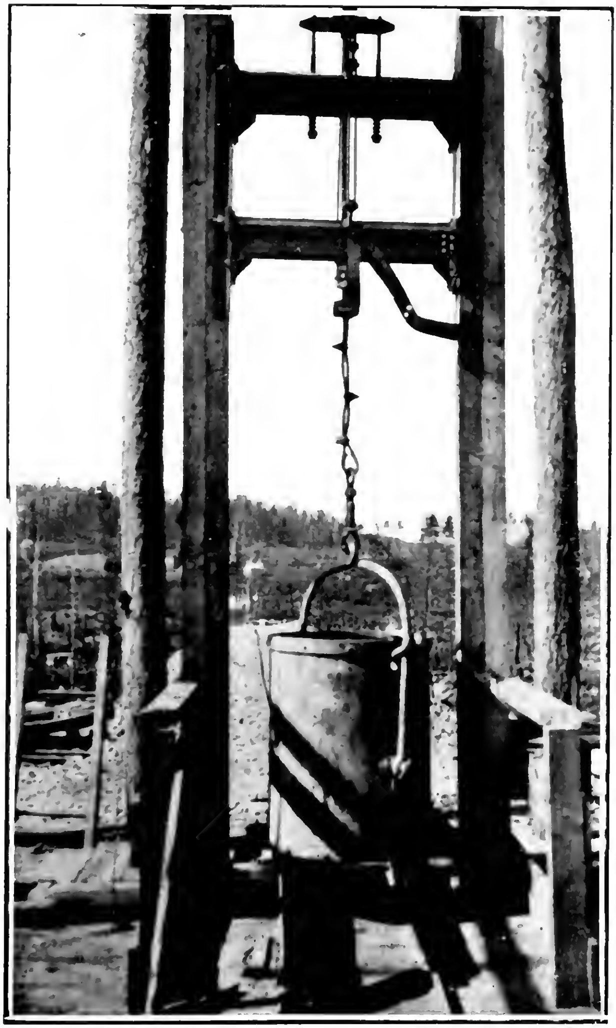
There were two accidents, involving the death of 4 men, from premature explosions while loading or lighting holes. The men present were killed in both accidents, consequently it was impossible to ascertain the exact cause of the explosions. Two men were killed as a result of picking into gelignite in the muck.



A	Attachment in normal position.
Aa.	Attachment tripped by crosshead stop.
B.	Clip in normal position.
Bb	Clip lowered through tripped attachment.
C	Draw pin.
D	Cable.
E.	Crosshead stops.
F.	Guides.
H	Crosshead

Sargeson's safety crosshead and attachment. Patented June 14th, 1910.

No lives were lost through asphyxiation from explosive gases. A number of men, however, were overcome with gas in mine workings during the year, but fortunately were easily resuscitated. With the increased development in the mines, natural ventilation of the underground workings will be bettered. The adoption of artificial ventilation, other than that due to air from the machine drills, in mine workings that have not,



Morin safety crosshead and bucket follower.

through force of circumstances, been able to secure sufficient outlets, is recommended. The installation of fans would, besides adding to the comfort and health of the miners, be an economic advantage to the company. Loss of time, through miners waiting for the smoke and gases to clear, is considerable, and if the workings were continually supplied with good air by fans the cost of installation and operation would soon be made up by the time saved.

Miscellaneous Accidents

Three men were killed as a result of falling down winzes. These are, as a rule, not properly protected. A winze is as dangerous as a shaft, and should be protected accordingly. The same conditions apply to sinking winzes and working from them as to shafts.

Surface Accidents

There were 19 men killed in surface accidents at the mines of Ontario in 1910, compared with 13 in 1909. Most of these accidents were from causes simple and easily preventible if a little care had been taken or intelligence shown. Work on the surface around mines, smelters, blast furnaces and concentrating mills should not be as hazardous as underground work. Still, in 1910 the fatality rate for Ontario was practically as great on surface as underground in proportion to the number of men employed.

Accidents at smelters, refineries and blast furnaces were responsible for 8 deaths. The labor employed at such plants is of the lowest type of intelligence of all our foreign labor. The men are generally unable to speak English, and seem to be slow in adapting themselves to their work and surroundings. They appear to lack initiative, and are as helpless as children in protecting themselves from injury. Out of the 8 deaths at smelters and blast furnaces, 5 were of foreigners. It is necessary for superintendents to put this ignorant class of labor at work where there is no hazard.

Three men were killed by being electrocuted. This is a new type of accident, and one that will need considerable attention in future. At present about 20,000 horsepower of electric energy is being used by the mines and works. This amount will be increased as the industry expands. The National Board of Fire Underwriters (U. S.) have formulated very strict rules respecting the installation of live wires and electrical machinery. The protection of human life is a matter of greater importance than the protection of property. Where the power is used below ground, the dampness, darkness and limited space make the hazard all the greater, and the necessity for careful and systematic inspection the stronger. Ignorance of electric power and its dangers necessitates greater protection, and the employment only of competent electricians to look after the electrical apparatus.

An Act to Regulate the Use of Electricity in Mines in Ontario was passed by the Legislative Assembly in 1911 as an amendment to the Mining Act of Ontario. It regulates the pressure at which the power is allowed to be used underground, and provides for the efficient insulating and grounding of all transmission lines and electric apparatus. It also provides for the enclosing of all live parts of switches, fuses and cut-outs, and for regulating the work when the current is on. Provision is made for the firing of shots by power cables, the use of electricity in thawing explosives and for electric drilling machines. The penalties for infringements of these provisions are the same as provided for offences against Part IX. of the Mining Act.

One workman was killed by being hit by a descending cage while leaning over the guard rail in the shaft house. This workman was perfectly familiar with the operation of the cage, but apparently for the moment lost sight of his surroundings. It might be a further safeguard to have gates at the surface landing sufficiently high to render it impossible to lean over them.

Four other men were killed by miscellaneous accidents.

Health of Miners

The mining camps of Ontario in 1910 were fairly free from disease of any kind, and compared favorably as to general condition of health with the rest of the Province. The typhoid epidemic of 1909, through a number of the camps, had taught the companies a valuable lesson, and greater attention was paid to the sanitary conditions and the supplying of pure drinking water.

Mine Hospitals

The mine hospital at Cobalt, owned by the Cobalt Mines Hospital, Limited, and conducted for the benefit of the miners by representatives of the mining companies of the Cobalt camp, has proved to be invaluable. All the sick or injured employees of the mines are well cared for. The employees subscribe 50 cents per man per month to the hospital, and any deficit is taken care of by the companies. The president of the hospital board, Mr. Tom R. Jones, superintendent of the Buffalo Mines, and the members of the board, have proved indefatigable in their work of making the hospital efficient.

The report of the president for the year March 1st, 1910, to February 28th, 1911, shows that 216 medical and 182 surgical cases were treated for the year. In the previous year 651 medical and 251 surgical cases were treated, which shows a general improvement for 1910 over 1909.

There were 54 cases of typhoid, of which 38 cases were from the town of Cobalt, cared for during the year.

The report shows that there were 9 deaths in the hospital from accident cases, and a recovery of 95.1 per cent. of the accident cases treated.

All the mines in the Cobalt camp are subscribers to the hospital, with the exception of the McKinley-Darragh, Ophir and King Edward.

The Canadian Copper Company's hospital at Copper Cliff is also one of the finest hospitals in northern Ontario. It was built and equipped by the company for their own employees; the latter contribute the regular rate per month for free medical attendance and hospital accommodation.

The success that has attended these two hospitals in their care of the miners should encourage other companies to follow their lead.

The Need of Technical Education for Miners

The time has come when directors of mining companies are realizing the necessity of appointing technically trained men in charge of mines. It is to be feared, however, that this move has been brought about by the desire to lessen the cost of mining, and by so doing reap greater rewards in increased dividends, rather than from a desire to lessen mine accidents. The appointment of thoroughly trained technical men will accomplish these results, through so organizing the work that a greater efficiency from all the workmen will be obtained. This increased efficiency means a more intelligent class of workmen and a lower accident rate. In annual reports of mining companies we see in the statement of expenditure a considerable item either under the head of accidents or insurance. This item of insurance generally includes payments to Employers' Liability Insurance companies. A mining company pays a certain percentage of its pay-roll to a Liability Insurance company, which agrees for this consideration to assume the responsibility for damage in the case of accident to employees. It is too often the case that companies insured in this way pay little attention to the claim of the employee for damages, alleging that this is the work of the Liability Insurance company. If operators would stop to consider this phase of the case, they would see that they are practising false economy. The lower the accident rate, the lower the liability rate of insurance. Accidents are classed in this report under five headings, namely: (1) accidents due to danger inherent to the work; (2) accidents arising out of defects in the mine workings; (3) accidents through fault of a fellow workman; (4) accidents through fault of injured person; (5) accidents impossible to classify.

Under the first heading, though the accidents are classified as being inherent to the danger of the work, they are not necessarily unpreventible. Here is a field for the scientifically trained man to work out ways and means for minimizing the number of such accidents. The old class of miners have always looked on such accidents as unpreventible, thinking they must happen as long as mining continues. This is a mistaken way of looking at the matter. The governments of different countries have appointed corps of technically trained men to work on this subject with the object of

lessening the hazards to which miners are exposed. This applies particularly to coal mining. It is no less applicable, however, to metal mining, as statistics in this continent show that the accident rate in metal mining per thousand men employed is as high, if not higher, than in coal mining.

Accidents due to defects in the mine workings are preventible, and it is almost criminal for the manager and superintendent of a mine to have accidents of this nature. Managers are often retarded in the work of putting their mine workings in proper condition by owners or operators objecting to the additional cost. This is false economy, and, if wilful, places them amongst the worst type of criminals. It is more charitable, however, to take the position that they are ignorant of the dangers, and need to be educated. It is sometimes the case that managers issue instructions regarding the work to their superintendents and foremen. These men are practical miners who have worked up from being laborers to their present positions. They have become accustomed to certain dangerous practices, and though they have been ordered by the manager to report any defect or violation of rules, they omit to do so until the accident occurs. These omissions by the superintendent or foreman are not intentional or with a view of causing accidents; they are the result of not being able to grasp the exact meaning of their orders or to realize the danger of the practices they permit. In other words, they lack the mental training that persons in such responsible positions should have.

Reckless Workmen Endanger their Fellows

The accidents that are the most difficult to prevent are those due to the neglect of the injured person or his fellow workmen. No matter how safe the mine workings are, or how efficient and strict are the laws and their enforcement, the reckless and foolhardy employee can not only endanger his own life, but also the lives of his fellow workmen. Just so long as miners will carelessly handle explosives, or drill into old bottoms of holes, or neglect to tamp holes, or attempt to drill near missed holes containing powder, there will be fatal accidents from these causes. Such dangerous practices also jeopardize the lives of the other workmen. In the same class are the workmen who will work under loose rock or steal rides in buckets or skips. These men are not as a rule ignorant of the dangers, but in a sort of bravado take the chance. There is something wrong with a man's mental training when he does such things. He lacks that quality of training that will restrain him from doing things that are foolhardy.

The amount of earning power that is lost yearly to the industry at large through mining accidents is sufficient to make all those who are seriously interested in the industry think carefully of ways to prevent it. In 1910 there were 48 men killed in the mines of Ontario. Assuming that each of these workmen had still an earning power of $5,000, we find that $240,000 was lost to the country. In addition to this was the time lost by men injured in mines and thus unable to work for periods longer or shorter. Also some men were so crippled in accidents that they will never again have the same earning capacity. We thus see that upwards of $300,000 of earning power was destroyed in the mining industry in Ontario in 1910.

What means can be adopted to save this amount, and by so doing save suffering and distress to hundreds of people? If, as the writer has endeavored to prove, a large number of the accidents are the result of lack of mental training both in the workmen themselves and up through the scale to the owner or operator, it is high time that some combined effort should be made to remedy this defect. In this age of agitation for technical training, the mining industry, in so far as the workmen themselves are concerned, has been neglected. Metal miners are a cosmopolitan class, necessarily so by the uncertain length of life of the mines. It is, therefore more difficult to establish training schools where the families of these miners would have the advantage of at least a good primary education. If the mining companies would interest themselves in this phase of the case, much could be accomplished. We see in the cities technical schools where the young mechanic can secure a training along lines that assist him in

his work. Why should this not be applicable also to the mines? In Ontario there are a large number of young men just entering the field of mining. It would seem that this field for training should not be neglected.

The fatal accidents that occurred during the year are described fully below, after which is given a table of fatal and non-fatal accidents.

Algoma Steel Company

At No. 2 blast furnace of the Algoma Steel Company, on April 24th, Giovanni Buzzato, laborer, had his clothing ignited by the hot gases expelled, due to a slip in the furnace, and was burned so seriously that he died a few hours later.

The deceased was employed in unloading a car of limestone on the trestle over the ore pockets about 150 feet from the furnace. The latter had been working badly, and the men in charge were trying to let it down when the slip occurred. This caused considerable hot coke and limestone to be expelled through the explosion doors at the top of the furnace. Some of the hot coke struck Buzzatto and set his clothing on fire, burning him severely before assistance reached him.

The coroner's jury brought in the following verdict: "That Giovanni Buzzato came to his death through burns caused by what is termed a 'slip' at the No. 2 furnace of the Algoma Steel Company, which occurred on the morning of April 24th, 1910, said explosion being due to natural causes, and the jury do not consider anyone to blame. Having regard, however, to the number of accidents which have occurred and are liable to occur from similar causes, the jury is of opinion that some better means of protection should be provided for the employees from accidents of this nature."

At No. 2 blast furnace on June 12th, Danied McLeod, top hoist-man, was severely burnt by hot gases expelled from the furnace by a slip, causing his death on June 15th.

The top-hoisthouse is located about 50 feet from the top of the furnace and on a level with it. The duty of the hoistman is to hoist the charges of ore, fuel and flux, and watch that the furnace is taking the charge properly. For this he has a test rod 20 feet in length operated from the hoisthouse, and is supposed to lower the rod into the furnace about every five minutes to see that the charge is sinking properly. If the charge hangs up in the furnace for more than 15 minutes without moving, the hoistmen are instructed to notify the blower. The furnace had been working well on the night shift of June 11th and up to 10 o'clock on the morning of June 12th, McLeod did not report any hanging up. About 5 minutes after the last charge had been put in, there was a slip in the furnace which caused hot gases to be expelled from the explosion door. These gases were blown by the wind against the top-hoisthouse in which Daniel McLeod was working, setting fire to the window frames and the floor, and burning McLeod very seriously.

The coroner's jury brought in the following verdict: "That Daniel McLeod came to his death as a result of burns caused by an accidental explosion of gas at the No. 2 furnace about 10 a.m., June 12th."

Atikokan Iron Mine

At the Atikokan mine on September 16th, Aleck Oja, machineman, was killed by being struck on the head by a falling rock.

The accident occurred in the east stope about 10 feet below the surface. Oja and his helper had blasted a number of holes in this stope, and after finishing blasting had been ordered by the foreman to scale. They were standing on a bench about 10 feet from the surface when Oja started to scale down the side of the stope, using a scaling bar about 10 feet in length. He had been working only a few minutes when he loosened a large piece of rock which fell on him, striking him and carrying him down the stope a distance of about 40 feet. When picked up, it was found that his skull was fractured.

The coroner, Dr. Laurie of Port Arthur, was notified, but not being aware of the requirements of the Mining Act did not hold an inquest, and the deceased was buried before instructions could be given from the Department. An investigation into the accident was made by the Chief Inspector of Mines and the evidence of the men taken under oath.

Beaver Silver Mine

At the Beaver mine, on November 4th, Mytro Poirer, mucker, was killed through falling down a winze.

The winze is sunk from the 200-foot to the 300-foot level, with a station at the 250-foot level. A small cage is used for hoisting in the winze. Poirer was mucking on the 250-foot level, and about 5 o'clock went out to the winze and asked his partner to ring down the cage. This was done, but the cage not coming at once, his partner went back into the drift, leaving Poirer standing in front of the winze with his hand on the raised guard-rail. It is thought that when the cage came down, Poirer attempted to board it without ringing it to the level, and in this way fell into the winze.

The coroner's jury brought in the following verdict: "That Mytro Poirer came to his death at the Beaver mine, on November 4th, as the result of an accident from falling down the shaft; and that the Beaver Mining Company should be censured for their negligence in not keeping the shaft protected with a guard-rail."

Bishop Silver Mine

At the Bishop mine, on February 8th, Olaf Moseid, miner, was killed by an explosion of gelignite, caused by cleaning out a hole that had been blasted.

The previous day a round of holes had been fired in the shaft, which was 57 feet deep, and the broken material hoisted. When this shift came off work they reported to the other shift that there was one missed hole in the bottom of the shaft. The new shift after coming on work found the missed hole, but did not blast it until 11.30, when Olaf Moseid stated that he was going to burn it out. He put a piece of fuse in the hole, without putting any exploder on it, and lighted it. When he came back to work he proceeded to clean out this hole, using a gun made of iron pipe. In the course of this procedure the explosion occurred.

The coroner's jury brought in the following verdict: "That Olaf Moseid met his death at the Bishop mine, on February 8th, by an explosion of gelignite, caused by his own negligence."

Canada Cement Company

At the Lehigh quarry of the Canada Cement Company, on August 19th, Allan Brant, trammer, was killed by being struck by a rail which was being used as a lever to replace a car on the track.

Brant was engaged with several other men in replacing a car which had run off the tracks. To do this they were using a length of quarry rail as a lever. In some way the rail slipped from under the car and swinging around struck Brant, knocking him down and falling on him, with the result that he sustained a compound fracture of the skull.

The coroner's jury brought in the following verdict: "That Allan Brant came to his death accidentally at the quarry of the Canada Cement Company, on August 19th, through the negligence of the Canada Cement Company, in not having proper appliances for replacing cars on the track."

Canadian Copper Company

Creighton Mine

At the Creighton mine, on February 10th, John Irish, scaler, was so severely injured by having his leg and foot crushed under a piece of falling ore, that he died three days later.

Irish was engaged as scaler on the third level of the mine. While barring down a loose piece of rock another piece beside it fell on him, breaking his leg in two

places and crushing it so badly that it had to be amputated just below the knee. It was found two days after the operation that the flesh had started to decay. His leg was consequently amputated again, about 3 inches above the knee, after which operation he died in about an hour. The stope had been scaled the day before. It was the duty of the deceased to see that all the loose rock was scaled down.

The coroner's jury brought in a verdict of accidental death.

At the Creighton mine, on September 8th, Yojo Wanio, drill runner, was killed by being struck by falling rock.

The deceased was drilling on a bench about 50 feet above the floor of the open cut, on the hanging wall side of the stope. Just back of and above him there was a cutting-in stope, about 30 feet wide and 25 feet high. The roof of this stope had been arched and the deceased was working on a bench between this cutting-in stope and another one of the same kind. Just before the large piece of rock fell a number of small pieces dropped, warning the men that it was dangerous. They all sought safety with the exception of Wanio, who got behind and under the drill, which he apparently thought would protect him. When the large piece of ore fell it struck the leg of the tripod of the drill and jammed the deceased under it, crushing him so badly that he died a few days afterwards.

The coroner's jury brought in a verdict of accidental death.

At the Creighton mine, on October 4th, Peter Klorodiski, block-hole driller, was killed through drilling into an unexploded block-hole.

The accident occurred at the fourth level of No. 2 shaft. The deceased had been employed as a block-hole driller for about three weeks, his duty being to drill short holes in all the large pieces of ore that could not be handled, and to blast them. The block-holer on the night shift had fired 10 block-holes at midnight and had drilled 5 others before going off shift. Klorodiski, after coming on shift, drilled one short block-hole and was starting on the second when the explosion occurred. The piece of ore in which he was drilling was several feet in length and was broken by the force of this explosion. It appeared that Klorodiski must have drilled into an old hole that had been loaded but had failed to explode.

The coroner's jury brought in a verdict of accidental death, but blamed Klorodiskl for not cleaning off the rock properly before starting to drill.

Creighton Mine Yards

At the Creighton Mine yards of the Manitoulin and North Shore railway, on June 30th, Samuel Eyre, brakeman, was run over by a car.

The deceased was a rear brakeman on an ore train, owned and operated by the Manitoulin and North Shore railway, which takes ore under contract from the Creighton mine to Clara Belle siding. The procedure at the mine after the cars are filled at the rockhouse is to allow them to run by gravity to the swamp, where they are picked up by the locomotive and hauled to the mainline. On the day this accident occurred two cars were standing near No. 1 rockhouse and four other cars were at No. 2 rockhouse in charge of two Italians, whose duty it was to control their speed when going down grade. The four cars were started, and running down grade apparently uncontrolled, struck the two at No. 1 rockhouse. The deceased in some way was under the two cars, whether having fallen from the top of the cars, or having been engaged in making a hose coupling, is not clear. He was dragged about ten car lengths and died a few minutes after. The Italians in charge of the four cars asserted they were unable to control their speed.

The coroner's jury brought in the following verdict: "That Samuel Eyre came to his death by being run over by a car which was struck by four loaded cars, and that the present system of running cars of ore from No. 2 rockhouse to what is known as the swamp is unsafe and should be remedied."

No. 2 Mine

At No. 2 mine, on December 22nd, John Kauppi, drill helper, was killed by being run over by the skip while he was attempting to leave it near the surface when it was in motion.

After stopping work on December 22nd, Kauppi and four others started to walk from the sixth level to the surface. When they reached the fifth level Kauppi proposed that they ride up on the skip. The others refused, but Kauppi stated he was going to ride up anyway. When the other men were at the third level the skip passed them with Kauppi in it. Not appearing at the dry-house some minutes later, search was made, and his body was found on the skip road 60 or 70 feet from the surface landing. It is supposed that Kauppi, in order to avoid being caught disobeying rules, attempted to leave the skip before it reached the surface, and in so doing was run over by the skip.

The coroner's jury brought in the following verdict: "That John Kauppi came to his death on December 22nd, through injuries while riding on a skip contrary to rules."

Smelter

At the smelter of the Canadian Copper Company, on June 8th, Artymon Kukulnisk was killed by being struck with a bar he was using in taking a shell from a slag pot.

The deceased was employed on the slag dump, it being his duty to help dump the slag pots that are hauled out by the engine. He was at this work on the night of June 8th, when part of the shell struck the bar he was using, forcing it against his abdomen and causing perforation of the small intestine.

The coroner's jury brought in a verdict of accidental death.

On August 26th, D. L. Antonio, converter-man, was killed by being crushed between a ladle and a car.

The deceased was in charge of No. 4 converter, and had been at work about 18 hours. The morning was rather hazy, so that the crane-man, who was in a pulpit about 40 feet above the floor, could not see very distinctly. In lifting the ladle, which weighs about 3 tons, it swung a little, owing to the crane being off centre. Antonio was leaning against the car, apparently dozing, as he made no effort to get out of the way when the crane-man shouted to him. He was crushed between the ladle and the car, dying shortly afterwards.

The coroner's jury brought in the following verdict: "That D. L. Antonio came to his death on August 26th, through an accident due to negligence on his own part."

While engaged in construction work at the new reverberatory furnace, on November 24th, Enrico Bedino was killed by being struck on the head by a falling shear leg.

The deceased was employed as shift boss looking after a gang of Italians who were at rock work, on the excavation for the new reverberatory plant. On the day of the accident the superintendent of construction work had ordered Bedino and his gang to a place some 25 yards distant, to be out of the way of the erection of a mast for the derrick. The mast was about 60 feet long and was erected by means of a rope fastened to the top, passing over a pair of shear legs placed about half-way down the mast, and then to a hoist on the railway some distance away. These shear legs were held in position by a couple of braces until the strain of the cable would come on them. While this was going on Bedino had strolled over from where his gang were, and stood watching the men at work on the erection of the mast. Without any warning one of the braces holding up the shear legs fell, allowing the shear legs to fall. One of them struck Bedino on the head, fracturing his skull, from which injuries he died about seven hours later.

The coroner's jury brought in the following verdict: "That Enrico Bedino came to his death through being struck on the head by a shear leg, and that the said accident was due to his negligence in not being with his gang some 25 yards away."

Canada Iron Corporation

At the blast furnace of the Canada Iron Corporation at Midland, on December 5th, Angus Crossen, repair-man, was asphyxiated by furnace gas while engaged cleaning out the chutes at the top of the furnace.

The furnace where the accident happened was blown in in August, 1910. It is of Roberts design, having a rated capacity of 300 tons of pig-iron per day.

About 11.30 p.m. on December 4th, Crossen asked for Mike Pisardo to go to the top of the furnace with him. The superintendent had previously instructed Crossen never to go to the top of the furnace without taking some man with him, and then not to remain more than 15 minutes. On the night of the accident, Crossen found that the ore was sticking in the chute at the top of the furnace owing to frost. He took a bar and shovel and started to clean it down, and told Pisardo to assist him. They worked at this for about 10 minutes, when Crossen was overcome by gas. He was drawn out on a girder by Pisardo, who then started for assistance, but was also overcome by gas before he got down. The blower of the furnace, becoming alarmed at the length of time the two men were remaining at the top of the furnace, went up to investigate and found Crossen and Pisardo both unconscious. The latter recovered, but Crossen died.

The coroner's jury brought in the following verdict: "That Angus Crossen came to his death on Monday, December 5th, through inhaling gas at the smelting works of the Canada Iron Corporation, Limited, in discharging his duties at the top of the furnace. That the accident was due to disobeying of orders in remaining too long in close proximity to the gases exuding from the furnace, and furthermore in not placing his helper in proper position to give the necessary alarm for assistance. That no blame can be attached to the company, as they have, by instructions and alarms, taken every precaution possible in safeguarding the lives of their workmen."

Casey Silver Mine

At the Casey mine, on May 26th, John Loucks, mucker, was killed through picking into gelignite that had been left either in the bottom of an old hole or in the muck.

The accident occurred on the 220-foot level of the mine, where a round of four holes had been fired on the morning of May 25th. Four reports were heard, and, during that day, most of the rock broken had been mucked out. Loucks was finishing this work, and was taking up the last bucket of rock on the bottom of the drift when the explosion occurred, which injured him so seriously that he died on June 4th.

The coroner's jury brought in a verdict of accidental death.

City of Cobalt Silver Mine

At the City of Cobalt mine, on May 4th, Oliver Martell, machine runner, was killed through an explosion caused by drilling into the bottom of an old hole.

The deceased was employed in driving a cross-cut on the 200-foot level. On May 3rd, Martell and his helper blasted a round of 8 holes in the cross-cut. This was mucked out that night, but no drilling done. On May 4th Martell set up his machine and started drilling in the same heading. He had drilled one new hole, deepened the breast hole about a foot, and started to drill in the bottom of the centre cut-hole when the explosion occurred. It is impossible to say what caused the gelignite to be left in the bottom of this hole when the rest of the hole exploded. Martell, however, was deliberately violating the Mining Act by drilling in this old bottom. The superintendent and the shift bosses proved that they had given instructions a number of times that no drilling should be done in the bottoms of old holes.

The coroner's jury brought in a verdict of accidental death, but recommended that notices printed in the different languages should be posted at the shafts forbidding the practice of drilling into old bottoms.

Cobalt Union Silver Mine

At the Cobalt Union mine on November 16th, Stephen Labelle, mucker, had his skull fractured by being struck on the head by a falling bucket, due to the breaking of the eyebolt in the horse whim.

The shaft where the accident occurred was 100 feet deep and was being sunk by contract by two French-Canadians, in whose employ Labelle was at the time of his death. The shaft was cribbed down with ladder-way and platforms to within about 20 feet of the bottom. Hoisting was being done with a horse whim and derrick, the driving beam being used as a brake by pressing it against the drum. Connection between the driving beam and the drum is made by a movable hook fastened to the beam and fitting into eye-bolts attached to the drum at different places. The eye-bolts were made of 7-8-inch round iron. Labelle and Felix Inivillion were engaged mucking in the bottom of the shaft and were sending up a bucket of muck. When the bucket started Inivillion stepped to the end of the shaft under the protection of the ladder-way, but Labelle stayed directly under the ascending bucket. When the bucket was up 25 or 30 feet the eye-bolt in the drum snapped, leaving it free to allow the bucket to drop to the bottom, where it struck Labelle, killing him instantly.

Coniagas Reduction Company

At the reduction works of the Coniagas Reduction Company, on September 28th, Antonio Tari, laborer, was killed by being crushed under a large radiator coil.

Three Italians were engaged in taking down the framework surrounding a radiator coil. After the framework was removed, the foreman went to another part of the plant to get some tackle for removing the radiator coil, which weighed about 500 pounds. While the foreman was away, the four Italians, with the aid of three others who had been employed in unloading a car of coal outside the building, attempted to move the coil. In doing so it toppled over, falling on Tari and crushing him so badly that he died almost instantly. Tari was one of the Italians employed unloading the car of coal, and had not been put at this work by anyone in authority. They had been asked by one of the Italians working on this coil to help them.

Owing to the coroner at Thorold being unaware of the law requiring inquests to be held on all fatal accidents at mines, he gave orders for the burial of Tari before the Bureau of Mines was notified of the accident. An investigation was afterwards made by the Chief Inspector of Mines, and it was not considered necessary to exhume the body in order to hold an inquest.

Deloro Mining and Reduction Company

At the Deloro Reduction works, on August 8th, Jan Koztouski, laborer, was electrocuted while handling the switch in attempting to start the motor.

The deceased was in charge of the ball mill, which is operated by an electric motor at a pressure of 550 volts. The switch controlling the motor is an ordinary three-pole switch attached to the wall near the motor. During the morning of the 8th instant, it had been necessary to shut off the power and stop the machine twice. This was done the first time by the foreman, and the second time by the oiler, the deceased having no authority to touch the switch. About four o'clock in the afternoon the belt came off the ball mill, and, in the absence of the foreman, Koztouski, it is presumed, went to the switch and shut off the power. In so doing his hand must have come in contact with the exposed metal of the switch, and he received a shock which resulted in his death. The insulated handle had come off this switch, and had not been replaced. The foreman and oiler, in opening and closing the switch, had taken hold of the insulating bar joining the three poles.

The coroner's jury brought in the following verdict: "That Jan Koztouski came to his death on the 8th of August at the Deloro Mining and Reduction Company's works, through coming in contact with an electric switch."

At the same plant, on November 23rd, Samuel Milligan, foreman, was severely burned by a fall of hot flue dust.

The accident occurred in the dust chamber adjoining the cupola furnace. The duty of this chamber is to catch the flue dust, consisting of fine particles of ore and coke, which are carried over from the cupola furnace. On November 23rd instructions were given to have this chamber partially cleaned, as it was thought to be too full to permit the furnace to do good work. The furnace was therefore banked, and the men were set to work to clean out the chamber. This work had been going on for about three hours, and the chamber was partially cleaned out when Milligan came round, took a shovel and stepped inside the chamber. He had been there but a few minutes when there was a fall of flue dust, which filled the entrance to the chamber to a depth of four to six inches. Milligan managed to crawl out of the chamber, when it was found that he was quite badly burnt. For seven days after he was burned he made fairly satisfactory progress, when he suddenly contracted pneumonia, from which disease he died on December 3rd. The doctors stated that the man's vitality was so low, as a result of the injuries he had sustained, that he was easily attacked by pneumonia, and that the burns were primarily the cause of his death.

The coroner's jury brought in the following verdict: "That Samuel Milligan came to his death as a result of burns received at the plant of the Deloro Mining and Reduction Company on November 23rd, the result of an accident, and that we do not consider either the company or the deceased guilty of culpable negligence."

Flinn Property

On lot 33 of the Gillies Limit, owned and operated by A. Rex Flinn, Tony Colleti, laborer, was crushed on July 30th by the caving in of the sides of a trench in which he was working. The trench was about 12 feet deep, the upper three feet being composed of rather loose, sandy soil, and the lower part of gravelly boulder clay, with here and there small pockets of coarse sand or gravel. The cave-in occurred on the up-hill side of the trench, where a wedge-shaped piece about 10 feet long had fallen in from the top. At the place where the cave-in occurred, there appears to have been a larger pocket of sandy material than usual, which would weaken the ground. The night previous to, and the morning of the day of the accident, there had been rain, and it is possible that the seepage had also weakened the ground.

The coroner's jury brought in the following verdict: "That Tony Colleti came to his death accidentally on July 30th, through the caving in of a trench on lot 33. We recommend that a trench over 10 feet in depth should be properly timbered."

Goodwin Lake Mine

At the Goodwin Lake mine, on January 15th, Frank Sheppard, drill helper, sustained injuries which resulted in his death, by falling from a bucket while riding away from a blast, and thus being caught by the blast.

Sheppard and Leo Doyle, machine runner, were engaged on Saturday morning, January 15th, in firing a round of 4 holes in the shaft. The usual blasting signal was given, and the engineer hoisted the bucket a few feet and lowered it again. Doyle then spit the fuse, and he and Sheppard got on the bucket and rang one bell. As the bucket started, Sheppard slipped off and caught on the side of the bucket with his hands. He held on until the bucket had ascended about 60 feet, when he called to stop the bucket. In endeavoring to get a fresh hold, he slipped and fell to the bottom. Doyle was hoisted to the surface and immediately sent the bucket to the bottom of the shaft, but Sheppard must have been so injured by the fall that he was unable to get into it. The four shots were shortly afterwards heard. As soon as possible the contractors, McDonald and Kenty, went down into the shaft and found Sheppard completely buried in the muck.

The work of sinking the shaft was being done by contract from the Goodwin Lake Mining Company. The shaft was found to be 90 feet in depth and was timbered to within 25 feet of the bottom, but there was no auxiliary ladder in place at the time of

the accident. Both the Goodwin Lake Mining Company and the contractors, McDonald and Kenty, were prosecuted under section 164, subsection 23, of the Mining Act, and were fined $100 each and costs.

The coroner's jury brought in a verdict of accidental death, but censured the Company and the contractors for violation of the Act.

Hargrave Silver Mine

At the Hargrave mine on June 8th, John Welsh, machine runner, and W. J. Parkinson, machine helper, were both accidentally killed by a premature explosion of dynamite.

The accident occurred in the drift of the 375-foot level of No. 3 shaft. A round of 13 holes was completed about 11 o'clock, and the first round of three holes was blasted before 12 o'clock. The second round of three holes was fired about one o'clock, and half an hour afterwards one hole was blasted. Seventy-five sticks of dynamite in all had been sent down with caps and fuse. Welsh and Parkinson went into the drift to load another round, and about 10 minutes after, the explosion was heard which killed both men. None of the holes were loaded, and it is impossible to say just what caused the explosion. It is probable that they attempted to clean out an old hole that contained some dynamite.

The coroner's jury brought in a verdict of accidental death.

Helen Iron Mine

At the Helen iron mine on August 6th, Antonio Micetich, track-man, was killed by being caught between the guard-rail of the cage and the shaft set, while trying to ring the bell when the cage was in motion.

The deceased was employed in the mine as track-man and had been in the employ of the company for upwards of six months. On the night of the accident, at about 11 o'clock, the deceased had put four rails on the cage at the surface, and had gone down to the fifth level, where the cage was stopped and N. Harman, pump-man, got on with him. The deceased then rang the signal for the cage to be lowered to the sixth level, but, through some error either in ringing or transmitting, the hoist-man received the signal to hoist. As the cage started up the deceased leaned out and tried to ring the signal to stop. In so doing he was caught between the first shaft set above the level and the guard-rail of the cage, and crushed.

The coroner's jury brought in the following verdict: "That Antonio Micetich came to his death through an accident due to his own carelessness, being caught by a shaft timber while trying to ring the signal from a moving cage.

Hudson Bay Silver Mine

At the Hudson Bay mine, on September 9th, J. R. Kinler, manager of the mine, was killed by falling from a high concrete pier at the mill.

Mr. Kinler, in company with Mr. McMillan, the mine captain, was looking over the construction work at the mill and was standing on a concrete abutment about 25 feet above the cement floor. While standing there he gave instructions to have some of the framework taken down. He assisted in this work, and was struck by the frames when they were loosened, and thrown backward off the abutment. He sustained a fracture of the base of the skull and died in less than an hour.

The coroner's jury brought in the following verdict: "That James R. Kinler came to his death by accident on September 9th at the Hudson Bay mine, by falling from the mortar block to the cement floor."

Kerry Silver Mine

At the Kerry mine, on June 7th, Obar Coutu, machine helper, was killed by being struck by a rock falling from the back of the drift in which he was drilling.

Coutu and his partner were engaged drilling a number of short holes at intervals of 50 feet, in which wooden plugs were to be placed for holding electric wires for lighting purposes. They were using an air hammer drill, and had drilled several holes. The

runner started the hole which caused the accident and had drilled about 4 inches when his helper took hold of the drill, while the runner went to the shaft for steel. He had got only about 50 feet away when his helper shouted. He went back and found that a piece of rock, weighing about 250 pounds, in which the hole was being drilled, had fallen, striking Coutu on the head and chest, from which injuries he died the following morning.

The coroner's jury brought in a verdict of accidental death.

La Rose Silver Mine

At La Rose mine, on April 21st, Patrick Gilmour, laborer, sustained a fracture of the ankle. He was taken to the hospital at Cobalt, where he made satisfactory progress untill April 28th, when he died very suddenly.

A post-mortem examination was conducted by Drs. Hair and McLean, who gave evidence that the repair of the fracture was progressing rapidly, but that the heart was practically empty of blood, and the muscles very pale, soft and flabby. They stated his death was due to the sudden cutting off of the blood from the heart. The accident which resulted in his fractured ankle was caused by Gilmour falling from a platform a distance of about seven feet.

The coroner's jury brought in the following verdict: "That Patrick Gilmour came to his death suddenly at the Red Cross hospital on April 28th, due to causes unknown."

Marathon Silver Mining Company

At the Marathon mine, on October 26th, Hugo Manderstrom, miner, was killed through the breaking ot a ladder-rung causing him to fall about 50 feet into the shaft.

On the morning of the above day a round was fired in the shaft, (which was 69 feet deep) that broke the landing on the lower set of timbers about 20 feet from the surface. In the afternoon Manderstrom, with the help of a couple of other men, took one of the 20-foot ladders, tied a 1½-inch rope to it and lowered it down through the manway, so that he could repair the landing which had been blasted. He then started down the ladder and had got down 10 or 12 feet when the rungs to which the rope was tied broke, and he fell to the bottom of the shaft. When he was taken out of the shaft it was found that his skull was fractured. He died shortly afterwards.

The coroner's jury brought in the following verdict: "That Hugo Manderstrom was killed in the shaft of the Marathon mine, on October 26th, through the accidental breaking of a ladder causing him to fall down the shaft."

McDonald Feldspar Mine

At the McDonald feldspar mine, on September 7th, Wm. Campsall, mucker, was killed by being struck by falling rock.

The open cut in which Campsall was working was about 40 feet in depth, with a hanging wall dipping about 70 degrees. According to the evidence taken at the inquest the walls of the open pit had been scaled a short time before the accident happened. No blasting had been done in that part of the open pit on the day of the accident. The rock fell from the wall about 20 feet above where Campsall was standing. It weighed between 200 and 300 pounds, and the blow caused a fracture of the skull. Campsall died about 40 hours later.

The coroner's jury brought in the following verdict: "That Wm. Campsall came to his death at the McDonald feldspar mine by being struck by a rock falling from the wall; that the wall of the mine was unsafe on account of insufficient scaling."

Mond Nickel Company

Garson Mine

At the Garson mine, on May 12th, Frank N. Silver, student, was electrocuted.

The deceased had been employed at the mine a little over a week, and had been part of that time helping the electrician. On the night of the accident he was

working as helper on a machine underground. At noon he went into the powerhouse along with the hoistman and engineer and ate his dinnêr there. When finished he picked up his dinner pail and started to leave the powerhouse. No notice was taken of what he did until 10 minutes later, when the engineer found him lying alongside one of the transformers. On investigation it was found he had placed his dinner pail back of one of the transformers, and, in so doing, the candle stick in his hat came in contact with one of the 22,000-volt wires, killing him instantly.

The coroner's jury brought in a verdict of accidental death.

At the Garson mine, on October 29th, Albert Johnson, drill helper, was killed through being struck on the head by a falling rock.

The accident occurred in an open pit about 30 feet long, 12 feet wide and 40 feet deep. The deceased was working in a cutting-in stope back from the open pit. He had just finished drilling and was coiling up the hose under the brow of the open pit preparatory to blasting, when the rock fell. The rock that fell came from the hanging wall near the surface, and had apparently been loosened through the freezing of water in the cracks of the rock.

The coroner's jury brought in the following verdict: "That Albert Johnson came to his death as a result of injuries sustained on October 29th, by being struck by a falling rock in No. 14 pit of the Garson mine, and that no person could be held responsible, as the defect in the wall upon close examination could not be detected."

Smelter

At the smelter of the Mond Nickel Company, at Victoria Mines, on December 8th, John Baby, converter liner's helper, was killed through being jammed between a ladle and a converter former.

The deceased had been engaged at his work lining the converter on the day of the accident until about 12.30 p.m. when he got down on the converter floor to put a chain on a converter former. The craneman was signalled to come over and lift this former into the converter shell. In accordance with the signal the craneman brought the crane over the former and was running a small block over to it, when it caught on the flange of a ladle near the former and upset it against John Baby, jamming him between the former and the ladle. Baby was taken to the hospital as soon as possible, but it was found that he was seriously injured internally.

The coroner's jury brought in the following verdict: "That John Baby came to his death on December 11th as a result of injuries sustained on December 8th, in the smelter of the Mond Nickel Company by being crushed underneath an overturned ladle, the said ladle being caught by the hook of a chain attached to a travelling crane. That his death was purely accidental and not due to any culpable negligence on the part of his fellow employees."

Moose Horn Silver Mine

At the Moose Horn mine, on November 19th, Geo. Allandale, mucker, was killed by an explosion caused by picking into a piece of gelignite in the muck.

Geo. Allandale and Daniel Kerney were mucking in a winze about 15 feet deep on the 100-foot level. Three rounds had been fired in the winze on November 17th. The foreman reported that he had received all the reports. On the morning of the 19th there were still four or five buckets of muck to hoist, and Allandale was using a pick to break up the loosened rock when the explosion occurred.

The coroner's jury brought in the following verdict: "That George Allandale came to his death from an explosion of gelignite and that there is a possibility that it was due to a cutoff hole, and, if such was the case, it showed negligence on the part of the company."

Northland Pyrites Mine

At the Northland mine, on March 29th, Saunders H. Frayne, drill helper, was killed by falling into a winze between the second and third level. A winze had been sunk on the ore from the second to the third level, about 50 feet north of the shaft,

and underhand stoping to this winze started about a month previously. At the time of the accident the lower bench in this stope was about 24 feet below the level. On this lower bench Frayne and his partner were at work. Frayne had his back to the winze and was tightening a nut on the machine when his wrench slipped, and he fell backwards into the winze, a distance of about 40 feet, and was instantly killed.

The coroner's jury brought in a verdict of accidental death.

Nova Scotia Silver Mine

At the Nova Scotia mine, on January 17th, C. Schmidt, laborer, received injuries by falling from a ladder, which resulted in his death about two days later.

The deceased was carrying a band of iron up a ladder leaning against a water tank. When about 12 feet from the ground the ladder canted, and the deceased lost his balance and fell sideways to the ground. In falling he struck his head on a plank. The doctors stated that the cause of death was injury to the brain substance causing inflammation.

The coroner's jury brought in a verdict of accidental death.

O'Brien Silver Mine

At the O'Brien mine, on May 5th, Wm. Jones, electrician, was killed by being thrown from an empty car that got beyond his control.

The deceased had been employed at the O'Brien mine about three months' as electrician. On account of the illness of the regular motorman, Jones had been put on to run the motor on the morning of May 5th. He had taken one car from No. 1 shaft down to the mill, coupled on two empties and was pushing them ahead of the locomotive down to No. 6 shaft. Just as he got on the grade going to the shaft he stopped the locomotive, and, for some reason unknown, pulled the lever which disengaged the coupling, and the head empty immediately started down grade. He at once started after the car, got into it and attempted to stop it by putting on the brake, but the car had got beyond his control. On account of the grade, the car was gathering speed all the time. It rounded the first curve, but when it came to the second it upset, throwing Jones out of the car. His head struck a stump, which caused a fracture of the skull. He died a few hours later.

The coroner's jury brought in a verdict of accidental death.

Ophir Silver Mine

At the Ophir mine, on September 21st, John Kinsey, pumpman, was killed by falling from the second to the third level, a distance of 100 feet.

The deceased was working around the sinking pump on the landing of the 200-foot level and accidentally stepped into the open shaft which had no guard-rail round it. He received injuries which resulted in his death the following day.

The coroner's jury brought in the following verdict: "That John Kinsey came to his death at the Ophir mine by falling down a shaft. That we censure the Ophir mine for neglecting to make provision for protecting the sides of the shaft by means of a guard-rail."

The Ophir Mining Company were prosecuted under section 164, rule 19, by the Inspector of Mines and fined $100 and costs.

Rochester Silver Mine

At the Rochester mine, on October 26th, John Dow, machine helper, was killed by falling into a winze 75 feet in depth.

John Dow and Wm. Burley were lowered into the winze to see if all the holes that had been blasted a short time previously had broken. They remained down about 15 minutes when they gave the signal to hoist. The bucket was hoisted to the collar of the winze and Dow started to get on the landing. In some way unknown he slipped and fell to the bottom of the winze.

The coroner's jury brought in the following verdict: "That John Dow came to his death as a result of injuries received by accidentally falling down a winze at the Rochester mine on October 26th."

Shamrock Silver Mine

At the Shamrock mine, on August 30th, Alex. Clark, machine runner, was killed by being jammed between the cage and the timber while riding up on the cage.

Clark's place of work was on the 300-foot level. He had been at the surface just before 11 o'clock and then went down on the cage to the 300-foot level, got off, and lighted his lamp but did not start work. He complained of a headache and decided to again go to the surface. When the cage was up about 35 feet the hoistman felt a jar and stopped the cage. An investigation was made and Clark was found jammed between the timbers and the cage. He was taken out promptly, and sent to the hospital, but died a few days later. Probably the explanation of the accident is that Clark, who was feeling unwell, took a faint or dizzy turn when the cage started and fell to the floor of the cage. His legs projecting over the platform caught on the shaft timbers.

The coroner's jury brought in the verdict, "That Alex. Clark came to his death accidentally, the result of injuries received at the Shamrock mine on August 30th, by being caught between the cage and the timbers of the shaft. We recommend that all mines have a bell rope in the working compartment of the shaft."

Silver Leaf Mine

At the Silver Leaf mine, on January 31st, Jas. Hope, drill runner, and Alex. Cristea, helper, were killed by a premature explosion, while engaged in lighting a round of holes in the shaft.

The accident occurred at the bottom on a 264-foot shaft. On Saturday, January 29th, a round of 18 holes had been completed, and Hope and his partner loaded 8 of them, using time-delay fuse for firing. They had great difficulty in getting this round fired, and, after trying several times, found that only 4 of the 8 holes exploded. They tried again on Monday morning, but succeeded in getting only 3 reports out of 6 holes connected. They then discarded the time-delay fuse and decided to use ordinary time fuse. They had loaded 13 holes, and the hoistman got the blasting signal and replied. About 30 seconds later an explosion was heard. About a minute later another report was heard, and, after waiting a few minutes, a couple of workmen were lowered to the bottom. Both men were dead before they were brought to the surface.

It is impossible to say what was the cause of the premature explosion. It may have been due to a fuse spitting into an untamped hole.

The coroner's jury brought in a verdict of accidental death, cause unknown.

Temiskaming Silver Mine

At the Temiskaming mine, on May 25th, Fred Bamber, head ore-sorter, while leaning over the guard-rail at the second landing in the shafthouse, was struck by the descending cage, causing him to fall down the shaft, and killing him instantly.

Bamber had apparently walked out of the rockhouse to the shaft and leaned over the guard-rail when the cage was at the landing above. The cage when lowered struck him on the back of the head, causing him to fall into the shaft. He fell a distance of about 400 feet, and landed on the hood of the cage, which was displaced by the fall, dropping him into the bottom of the car which was on the cage.

The coroner's jury brought in the following verdict: "That Fred Bamber came to his death at the Temiskaming mine, on May 25th, accidentally by falling down the shaft. We find the company free from all blame."

Trethewey Silver Mine

At the Trethewey mine, on August 24th, A Lefebvre, painter, was electrocuted through coming in contact with the high pressure wire while at work on the transformer building.

Lefebvre had been in the employ of the company for several months doing general painting round the mine. He had completed nearly all the odd jobs round the buildings with the exception of a board just above the point where the high pressure wires enter the transformer building. There appears to have been no definite instructions given to Lefebvre to paint this board. He had been warned by some of his fellow workmen to be careful when working near the wires, but did not realize the full importance of this warning. The men working on the top of the building heard a report and saw a flash of light. On investigating they found Lefebvre on the wires which carry 11,000 volts. It was necessary to get the current shut off before he could be removed from the wires, which required about 25 minutes.

The coroner's jury brought in the following verdict: "That A. Lefebvre came to his death at the Trethewey mine, on August 25th, by accident due to electrocution. That we strongly censure the Trethewey Mining Company for their carelessness in permitting their employees to work in such close proximity to wires carrying such high voltage as 11,000 volts. That signs be placed on all transformer houses and switch boards, giving the voltage in French and English."

At the same mine, on December 9th, Wm. Maki, drill runner, was killed through the breaking of a rope in hoisting his machine out of the winze.

Maki was working in a winze 60 feet deep below the 150-foot level. He had completed the drilling of a round of holes and was sending his machine and tools to the top before blasting. The shift boss told him to put his machine in the bucket and send it up as usual. Instead of doing this, Maki fastened a piece of rope that had been used in tying tools in the bucket, around the machine, and gave the signal to hoist. When the machine had reached a point about 20 feet from the top the rope broke, allowing it to fall, striking Maki on the head and fracturing his skull.

The coroner's jury brought in the following verdict: "That Wm. Maki came to his death accidentally as a result of injuries received at the Trethewey mine, on December 9th, by being struck by a falling machine that was being hoisted attached to the cable by a rope, by the deceased, which was contrary to orders."

Table of Fatal Accidents in 1910

Date.	Mine or Workings	Owner.	Name and Occupation of Injured.	Below Ground.	Above Ground.	Nature of Injury.	Cause of Accident.
April 21..	Blast furnace	Algoma Steel Co.	Giovanni Buzzato, laborer	....	1	Body badly burned	Slip of furnace expelled hot coke which ignited clothing.
June 12..	do	do	Daniel McLeod, top hoistman	....	1	Burned	Hot gases expelled by slip in furnace.
Sept. 16..	Atikokan	Atikokan Iron Co.	Aleck Oja, machine man	1	....	Skull fractured	Struck by falling rock.
Nov. 4...	Beaver	Beaver Consolidated Mines, Ltd.	Mytro Poirer, mucker	1	....	Both legs broken and head injured	Fell down winze.
Feby. 8..	Bishop	Bishop Silver Mines, Ltd.	Olaf Moseid, hand miner	1	....	Legs broken and bad flesh wounds	Explosion in blasted hole while cleaning it out.
Feby. 10.	Creighton	Canadian Copper Co.	John Irish, scaler	1	....	Leg broken and foot crushed,	Large piece of ore fell on him while scaling.
June 8...	Smelter	do	Artymon Kukulnisk, laborer	....	1	Rupture of small intestine, causing peritonitis,	Struck on abdomen by bar.
Aug. 26..	do	do	D. L. Antonio, converter man	....	1	Ribs broken and crushed in, causing internal injuries	Crushed between converter ladle and car.
Sept. 8...	Creighton	do	Yojo Wanio, machine man.	1	....	Body crushed	Struck by falling rock.
Oct. 1....	do	do	Peter Klorodiski, block holer	1	....	Legs badly lacerated,	Drilled into unexploded block hole.
Nov. 15..	do	do	Alex. Billinski, mucker	1	....	Skull fractured,	Struck by rock rolling down muck pile.
Nov. 21..	Smelter	do	Enrico Bedino, shift boss	....	1	Skull fractured,	Struck by falling shear leg.
Dec. 22..	No. 2	do	John W. Kauppi, drill helper	1	....	Body crushed	Run over by skip while attempting to leave it near surface.
June 30..	Railway	Manitoulin North Shore Ry. Creighton Yd's	Samuel Eyre, brakeman	....	1	Leg severed	Run over by cars.
Aug. 19..	Stone Quarry	Canada Cement Co.	Allan Brant, trammer	1	....	Fractured skull	While using rail as lever to replace car on track it slipped and fell on him.
Dec. 5...	Blast furnace	Canada Iron Corporation	Angus Crossen, repair man	....	1	Asphyxiated,	While cleaning out ore chute at top of furnace was overcome by furnace gas.
May 26...	Casey	Casey Cobalt M'g. Co.	John Loucks, trammer	1	....	Head injured, causing concussion	Struck pick into gelignite in bottom of old hole, causing explosion.
May 1....	City of Cobalt	City of Cobalt M'g. Co.	Oliver Martel, machine runner	1	....	Top part of head blown off	Started to drill into bottom of old hole causing an explosion.
Sept. 28..	Smelter	Coniagas Reduction Co.	Antonio Tario, laborer	....	1	Body crushed	Large radiator coil which was being moved fell on him.
Nov. 16..	Cobalt Union	Cobalt Union Mines, Ltd.	Stephen Labelle, mucker	1	....	Skull fractured,	Struck by falling bucket due to breaking of eye bolt in horse whim.
Aug. 8...	Smelter	Deloro Min. & Reduction Co	Jan Koztonski, laborer	....	1	Electrocuted,	While handling switch in stopping motor received shock.
Nov. 23..	do	do	Samuel Milligan, foreman	....	1	Severely burned, pneumonia was contracted, causing death Dec. 3rd,	Burned by fall of hot flue dust.
July 30...	Rex Flinn	A. Rex Flinn	Tony Colletto, labourer	....	1	Badly crushed	Caving in of trench.
Jan. 15..	Goodwin	Goodwin Lake Mines Co.	Frank Sheppard, drill helper	1	....	Body very badly cut	Fell from bucket while riding away from blast and was struck by blast.
June 8...	Hargrave	Hargrave Silver Mines	John Welch, machine runner	1	....	Skull fractured	While loading a round of holes a premature explosion occurred.
do	do	do	W. J. Parkins, machine helper	1	....	Head blown off	
Sept. 9...	Hudson Bay	Hudson Bay M'g. Co.	J. R. Kinler, manager	....	1	Skull fractured	Fell from high concrete pier of mill.
June 7...	Kerry	Kerry Mining Co.	Obar Coutu, machine helper	1	....	Laceration and fracture of the skull	Piece of rock in back of drift into which he was drilling, fell on him.
April 21..	La Rose	La Rose Mines, Limited	Patrick Gilmore, labourer	....	1	Ankle fractured	Died in seven days, death due to sudden cutting off of blood from the heart.

Table of Fatal Accidents in 1910—Concluded.

Date.	Mine or Workings	Owner.	Name and Occupation of Injured.	Below Ground.	Above Ground.	Nature of Injury.	Cause of Accident.
Aug. 6	Helen	Lake Superior Power Co.	Antonio Micetick, trackman	1	....	Injuries to lungs and bronchial tubes, causing hemorrhage	Trying to ring bell when cage was in motion, was caught between guard rail and shaft set.
Dec. 31	Craigmont	Manufacturers Corundum Co	Fred Molkentien, foreman	1	....	Head blown off	Explosion of delayed blast.
Oct. 26	Marathon	Marathon M'g. Co.	Hugo Manderstrom, miner.	1	....	Fracture of base of skull.	Ladder rung broke allowing deceased to fall about fifty feet into shaft.
Sept. 7	McDonald	McDonald Feldspar Co.	Wm. Campsall, mucker	1	....	Fracture of skull	Struck by falling rock.
May 12	Garson	Mond Nickel Co.	Frank N. Silver, student	....	1	Electrocuted	Touched 22,000 volt wire.
Oct. 29	do	do	Albert Johnson, drill helper	1	....	Head injured	Falling rock.
Dec. 8	Smelter	do	John Baby, liner's helper	....	1	Rupture of intestine	Jammed between ladle and converter former.
Nov. 19	Moose Horn	Moose Horn Mines Ltd.	Geo. Annandale, mucker	1	....	Killed almost instantly.	Picked into gelignite in muck.
Mar. 29	Northland	Northland M'g. Co.	Saunders H. Frayne, drill helper	1	....	Neck broken	Fell backward into winze.
Jan. 17	Nova Scotia	Nova Scotia Silver Cobalt M'g. Co.	C. Schmidt, labourer	....	1	Injured brain	Fell from ladder which was leaning against water tank, a distance of 15 feet.
May 5	O'Brien	M. J. O'Brien	Wm. Jones, electrician	....	1	Fracture of base of skull.	Thrown from empty car which was running away.
Sept. 21	Ophir	Ophir Mines, Ltd.	John Kinsey, pump man	1	....	Rupture of internal organs	Fell part way down shaft.
Oct. 26	Rochester	Rochester Cobalt Mines, Ltd.	John Dow, drill helper	1	....	Internal injuries.	While stepping off bucket slipped and fell into winze.
Aug. 30	Shamrock	Shamrock Silver Mines, Ltd.	Alex. Clark, machine runner	1	....	Fracture of base of skull	While riding upon cage jammed between cage and timber.
Jan. 31	Silver Leaf	Silver Leaf M'g. Co.	Jas. Hope, drill runner	1	....	Killed instantly	While lighting round of holes in shaft, one hole exploded prematurely.
do	Silver Leaf	Silver Leaf M'g. Co.	Alexander Cristea, helper	1	....	Killed instantly	While lighting round of holes in shaft, one hole exploded prematurely.
May 25	Temiskaming	Temiskaming M'g. Co.	Fred Bamber, head ore sorter	....	1	Head crushed	Struck by descending cage while leaning over guard rail in shaft house, causing his fall down shaft.
Aug. 21	Trethewey	Trethewey Silver Cobalt M'g. Co.	A. Lefebvre, painter	....	1	Electrocuted	Touched high pressure wire while working in transformer building.
Dec. 9	do	do	Wm. Maki, drill runner	1	....	Fracture of skull	Sent up drill by means of rope tied to cable, rope broke allowing it to fall and striking Maki.
			Total	29	19		

Table of Non-Fatal Accidents in 1910

Date.	Mine or Workings	Owner.	Name and Occupation of Injured.	Below Ground.	Above Ground.	Nature of Injury.	Cause of Accident.
July 7	Atikokan	Atikokan Iron Co.	A. Neilson, powderman	1	....	Bruises and flesh wounds	Premature explosion of sand blast.
Feb. 21	Belmont	Belmont Mines, Ltd.	W. C. Dean, machine man	1	....	Fracture of ankle	Slipped from ladder and fell 25 feet.
Feb. 12	Bonsall	The Bonsall Mines, Ltd.	John Daniels, engineer	....	1	Left leg broken	Using a bar to start compressor.
April 7	Buffalo	Buffalo Mines, Ltd.	Geo. Cleverly, miner	1	....	Eye injured	Premature explosion while fixing sand blast.
Aug. 6	do	do	P. Ricketts, drill runner	1	....	Spine seriously injured	Slipped while descending manway, falling on rail
Feb. 24	Creighton	Canadian Copper Co.	Kalli Lapala, drill runner	1	....	Lost sight of one eye	Struck by small piece of rock from drill.
Dec. 14	do	do	Kantala Rousouen, drill helper	1	....	Fracture of right thigh and left leg	Fell down stope about 20 feet.
Dec. 31	Cobalt plant	do	Chas. Hankin, oiler	....	1	Head injured	Arm caught between belt and pulley.
Nov. 18	Queensboro	Canadian Sulphur Ore Co.	A. Jeffery, drill runner	1	....	Fracture of arm	While hoisting cross-bar out of shaft, chain broke, allowing bar to fall.
May 1	City of Cobalt	City of Cobalt M'g. Co.	John Murphy, drill helper	1	....	Arm broken	Runner started to drill in bottom of old hole, causing explosion.
June 21	do	do	A. Larson, miner	1	....	Arm broken	Brake pin came out, dropping cage with men 60 feet.
do	do	do	J. K. Regan, miner	1	....	Ankle cut	
Nov. 2	Quarry	Clifton Sand, Gravel and Construction Co.	Arthur Lenahan, laborer	....	1	Fractured skull	Struck by sheave falling from derrick.
July 19	Townsite	Cobalt Townsite M'g. Co.	E. Johnson, machine runner	1	....	Right arm injured requiring amputation	While loading hole with gelignite, premature explosion occurred.
do	do	do	H. Hakala, machine helper	1	....	Flesh wounds	
Dec. 12	Smelter	Canigas Reduction Co.	E. J. Hilton, labourer	....	1	Rib broken	Wall collapsed while tearing down brick furnace.
Sept. 11	Crown Reserve	Crown Reserve M'g. Co	Edward Boyes, miner	1	....	Fractured toe	Bucket fell on toe.
Dec. 8	Smelter	Deloro M'g.& Reduction Co.	A. Savory, helper	....	1	Cut behind ear	Hit by handle of winch.
Feb. 16	Frontier	Haileybury FrontierM'g.Co.	Lauzon Fournier, miner	1	....	Lost sight of one eye	Struck by pick.
July 22	Blast furnace	Hamilton Steel & Iron Co.	Pasqualino Unsca, labourer	....	1	Foot crushed	Caught in hoist.
Sept. 5	do	do	Jas. Casali, labourer	....	1	Right wrist broken	Hoist started, causing him to fall.
Nov. 18	do	do	Roco Violo, labourer	....	1	do	Struck on wrist by falling wedge.
May 9	Hollinger	Hollinger M'g. Co	Jas Williams, drill helper	1	....	Eye severely injured	Picked into some loose gelignite in muck.
do	do	do	J. Gagnon, drill runner	1	....	Head cut	
Sept. 5	do	do	John Knash, mucker	1	....	Injured under right eye	Struck loose detonator in muck with pick.
Jan. 19	Richardson	Kingston Feldspar& M'g.Co.	Stuart Leeman, pit boss	1	....	Three fingers broken	Hand caught in sheave wheel.
May 31	Helen	Lake Superior Power Co.	S. Matizezuk, trammer	1	....	Finger crushed	Jammed between wall and car.
May 26	Magpie	do	Whitori Makela, labourer	....	1	Foot cut	Struck foot with adze.
Aug. 23	Helen	do	John Jones, miner	1	....	Very badly cut up	Box of caps exploded.
Sept. 22	do	do	E. Tomicic, miner	1	....	Bruised	Fell down raise.
Sept. 27	do	do	W. Kowunen, miner	1	....	Scalp wound	Slipped while tightening nut on machine and fell down raise.
Oct. 5	do	do	J. Falco, trammer	1	....	Right hand bruised	Caught between car and wall.
Oct. 12	do	do	Wm. Harris, skip tender	1	....	do	Caught between car and wall.
Oct. 18	do	do	J. Ranelink, trammer	1	....	Shoulder blades bruised	Struck by ore falling down chute.
Oct. 26	Magpie	do	Fred Aozak, labourer	....	1	Fracture of finger and bruises.	Barrel of gasoline fell on his hand.
Nov. 2	Helen	do	R. De Diana, miner	1	....	Cut on head	Struck by piece of rock from blast
Nov. 17	do	do	A. De Bon, trammer	1	....	Left ankle sprained, other bruises	Struck by falling material.
Nov. 21	do	do	Paul Paghwekine, trammer	1	....	Right thumb broken	Rock fell down chute and struck thumb.
Nov. 13	do	do	W. Moore, labourer	....	1	Leg bruised, causing septic condition	Struck by stone.
Dec. 9	do	do	G. Zanzi, trammer	1	....	Fracture of finger	Lump of ore struck finger when on edge of car.

Table of Non-Fatal Accidents in 1910—Concluded

Date.	Mine or Workings	Owner.	Name and Occupation of Injured.	Below Ground.	Above Ground.	Nature of Injury.	Cause of Accident.
Dec. 20..	Twp. 22, Range 12	Lake Superior Power Co....	Jos. Bolduc, labourer..........	....	1	Left hand blown off..........	Premature explosion of dynamite.
Dec. 31..	Helen	do	N. Martignago, miner..........	1	....	Fracture of right ankle	Timber fell on him.
Jan. 26..	La Rose..........	La Rose Mines, Ltd........	A. E. Burt, sampler......	1	....	Right leg fractured......	Fell from ladder while descending into stope.
Feb. 17..	do	do	A. Myrinayk, trammer	1	....	Leg bruised.....	Jammed between two cars.
Mar. 17..	do	do	R. Chartrand, timberman	1	....	Leg and arm bruised	Loosened piece of rock while scaling, which fell on him.
July 30...	Lawson	do	F. De Rico, labourer	....	1	Leg bruised.................	Trench 4 feet deep, caved in.
Aug. 8...	La Rose...... ...	do	L. Hatt, drill runner	1	....	Bruised knees..........	While scaling, loosened rock which fell on him.
Aug. 31..	do	do	R. Gilchrist, drill helper............	1	....	Finger amputated...........	Caught between drill and bar.
Nov. 10..	do	do	A. Morin, mucker..................	1	....	Big toe crushed.....	Caught between bucket and car.
April 11..	Little Nipissing..	Little Nipissing Silver Cobalt M'g. Co..........	John Smith miner..................	1	....	Thumb smashed	Rode down shaft on bucket, contrary to orders.
Oct. 25...	Lumsden.........	Lumsden M'g. Co.........	Wm. Dellenko, helper...............	1	....	Head bruised................	Fell about 25 feet down shaft
Aug. 1...	Craigmont	ManufacturersCorundumCo.	David Kilmartin, millman............	....	1	Fracture of thigh	Throwing belt off pulley.
Dec. 31..	do	do	Wm. Tracy, helper	1	....	Left eye destroyed..........	Caught by explosion.
June 13..	Savage.........	McKinley-Darragh-Savage Mines, Ltd...............	Nathan Bradley, machine man	1	....	Fingers blown off both hands.	Cleaning out old hole.
Feb. 26..	Smelter	Mond Nickel Co.......	Geo. Smith, mechanic...............	....	1	Leg broken	Piece of sheet iron on which they were standing gave way.
do	do	do	John Tracey, mechanic	....	1	Head injured......	
June 16..	do	do	Matti Wanki, trammer.	....	1	Leg fractured.....	Jammed by ore car.
June 7...	Nova Scotia......	Nova Scotia Silver Cobalt Mines	J. Kawal, cage tender...............	1	....	Internal injuries.	Piece of steel caught on timber jamming him against floor of cage.
Aug. 12..	Rochester	Rochester Cobalt Mines,Ltd.	A. M. Polson, hoistman.............	1	....	Bruised.....	Fell 20 feet into winze.
Dec. 19..	Cobalt Central Mill	Standard Cobalt Mines......	Rober Carter, jigman...............	....	1	Head bruised................	Struck by wrench, which had come in contact with fly wheel of crusher.
Nov. 11..	Swastika.........	Swastika M'g. Co..........	Malcolm McLaughlin, engineer	....	1	Leg broken, necessitating amputation	Using bar to start compressor.
Jan. 11...	Temiskaming	Temiskaming M'g. Co....	K. Sivin, drill runner...............	1	....	Hand bruised	Piece of rock fell on hand.
Aug. 13..	do	do	Felix Knash, miner	1	....	Back sprained.............	While being lowered in cage, hoistman threw left hand drum out of gear, brake not on right hand drum, and cage dropped about 10 feet.
do	do	do	N. Yanta, miner.....................	1	....	Leg injured	
do	do	do	D. Maki, miner	1	....	Fracture of forearm........	
Jan. 22..	Waldman	Waldman Silver Mines, Ltd.	John Whalen, tender......	....	1	Right arm broken...........	Caught between car and door of shaft house.
July 6....	do	do	Frank McCumber, trammer	1	....	Fractured finger,............	Hand caught between car and chute.
			Total............................	47	20		

MINES OF ONTARIO

BY E. T. CORKILL, Chief Inspector of Mines

I.—NORTHWESTERN ONTARIO

Northwestern Ontario comprises an area extending from Port Arthur north to the Albany river and west to the Manitoba boundary. Throughout this area mines are being worked for gold, silver, iron and iron pyrites. In addition, sandstone and granite are being quarried for building purposes, for concrete work and for street paving. All this area is more or less mineralized, and mines are, or have been, in operation over much of the explored part. Gold appears to be the most widely distributed mineral, and for the winning of it the most development work has been done. The gold mines have had a most uncertain existence. Some of them have produced considerable gold, for example, the Mikado, Sultana and Regina. Of these the Mikado is the only one in operation at present. This mine produced, up to the time the old company ceased operations in 1903, in excess of $500,000. The last two or three years have seen the least activity in gold mining in this area and the lowest production since 1895. Since the re-opening of the Mikado in 1910, by Capt. H. A. C. Machin, M.P.P., a renewed interest seems to be taken in the district, and it is expected that several other mines will be re-opened in 1911.

Silver mining in the Port Arthur district is still at a low ebb, the production being very small and but few mines in operation.

There was but one shipping iron mine in 1910. This was the Atikokan, which ships to the blast furnace at Port Arthur.

No iron pyrites was shipped from the Northern Pyrites Company's mine near Graham in 1910. The mine was, however, worked steadily, and a considerable tonnage of ore blocked out. Shipments will begin with the opening of navigation in 1911.

The three transcontinental railways of Canada traverse northwestern Ontario. The Fort William branch of the Grand Trunk Pacific runs from Fort William in a northwesterly direction to Graham on the National Transcontinental, a distance of 188 miles, while the Port Arthur and Duluth extends from Stanley Junction on the Canadian Northern southwesterly 40 miles. These several lines, together with the numerous water routes which they intersect, have made accessible a large area of mineral lands and furnish ready means of access to the prospector in his search for mineral.

Lake of the Woods Area

Mikado Gold Mine

This property was re-opened early in 1910, after having been closed down since April, 1903. It is now being worked by the Kenora Mines, Limited, with Capt. H. A. C. Machin, president, and Mr. R. B. Nickerson, superintendent.

The incline shaft put down through the old stopes by the former management is about 1,300 feet in length. The vertical shaft, about 75 feet from the mouth of the incline shaft, is open to the fourth level, a depth of 240 feet, but no work is being carried on through it. The present owners are working on the second, fourth and seventh levels, which are at vertical depths of 120 feet, 240 feet and 360 feet. On these levels drifts are run west on the vein, the seventh level drift being now in 250 feet from the shaft. A winze is being sunk from the fourth to the seventh level.

The mill, consisting of 20 stamps, has been re-modelled and run for some weeks. The old cyanide plant has been taken out, and preparations made for installing a modern mill. The mill is not being run at present, all the force being on development work underground.

The rock-house has been re-modelled and the power plant fitted up and put in operation.

Instructions were given with regard to operating the incline shaft.

Cameron Island

The Cameron Island Syndicate during the winter of 1910-11 made an examination of the Cameron Island mine, situated about 6 miles from the Mikado, and are making preparations for resuming work there.

The Ophir mine, about half a mile south of the Sultana, has been re-opened. A shaft is being sunk.

Work was also done on a copper prospect on an island in Lake of the Woods. A shaft has been sunk about 60 feet and work is still going on.

Upper Manitou Lake Area

With the exception of the Detola, the properties in this area were all idle the first of January, 1911.

Paymaster

The Paymaster erected a 10-stamp mill in 1910, and a month's mill run was made on the output. After this test, operations at the mine ceased entirely.

The Laurentian is still kept un-watered, but no other work is being done.

Detola Gold Mine

The Detola Mining and Development Company, with Mr. Dryden Smith as superintendent, have continued operations at the Detola during the year. The shaft has now a depth of 235 feet, and the second level cross-cuts have been driven 100 feet east and west, respectively.

A 10-stamp mill was erected on the shore of Mud lake during the summer of 1910, and a tramway built from the shaft to the mill.

Minnehaha

On the north shore of Minnehaha lake the Minnehaha Mining and Smelting Company were working at intervals during the year. Very little mining work was accomplished.

Sturgeon Lake

St. Anthony

The only property on which any extensive mining work was carried on during the summer was the St. Anthony. At this mine, under superintendent R. Sandow, the mine was re-opened and mining continued until December 1910, when it was closed down temporarily. While in operation the shaft was sunk an additional 50 feet and further drifting done on the 100-foot level.

An option was taken on this mine by Mr. Geo. Glendenning, of Toronto, in March, 1911, and work again started. It is proposed to run the stamp mill steadily as well as continue the underground development work.

In addition to this mine there were a number of prospectors engaged in assessment work on claims situated in the area around Sturgeon lake. The route to the camp has been described in former reports of the Bureau.

Dryden Area

League Mine

The Shareholders Protective League, Limited, of Detroit, have taken over the old Gold Coin property and were engaged in mining work during the summer of 1910. Mr. Emil Froh, of Detroit, is chairman, and Mr. Jas. J. Kaighan superintendent in charge at the mine.

One shaft has been sunk to a depth of 80 feet, ahd another, on which work was being done at the time of inspection, 35 feet. The plant consists of a 45-h.p. boiler and hoist.

Vermilion (Northern) Pyrites Mine

The control of this mine, situated on Vermilion lake about 8 miles west of Graham and 2½ miles south of the National Transcontinental railway, was taken over in 1910 from the Northern Pyrites Company by the General Chemical Company. No shipments were made during the year, but development work underground was energetically carried on to prove the extent of the ore body. Both No. 1 and No. 2 shafts have been sunk to the third level, No. 1 being on the hanging wall side of the ore body, and No. 2 in the foot wall; they are about 350 feet apart. On the second level drifts have been run east on the vein 300 feet from No. 2 shaft. No. 1 shaft is connected with No. 2 shaft by a drift along the foot wall in the ore. Cross-cuts have also been driven at 100-foot intervals on this level to ascertain the width of this ore body. On the third level the ore body has been cross-cut from No. 2 shaft.

A new plant is being installed consisting of three 100-h.p.boilers, a 14-drill compressor and double drum hoist for No. 2 shaft. The aerial tram line to the railway is to be repaired, and it is expected to start shipping ore with the opening of navigation this year.

Mr. H. V. Smythe is superintendent, employing about 50 men.

Atikokan Iron Mine

Work was resumed here in May, 1910, and has since been carried on continuously, from 100 to 150 tons per day being shipped to the blast furnace at Port Arthur. The ore is mined from the body about 50 feet from the mouth of the tunnel. Raises were put through east and west of the tunnel, and the ore broken down by underhand stoping. The west stope is about 50 feet in width and the east one 35 feet. An adit has been driven into the ore body at a point 500 feet east of the old workings and some ore taken out.

Mr. F. Rodda is superintendent, employing about 40 men.

Atikokan Blast Furnace

The blast furnace of the Atikokan Iron Company, at Port Arthur, was put in blast in May, 1910, and has since been in operation. Owing to the severity of the winter the company have always ceased work during the winter months until this year.

Mr. J. D. Fraser is manager of both the blast furnace and the mine.

Dominion Bessemer Ore Company

This company did considerable work on lot C, in the township of Macgregor, in 1909, and shipped some ore. They ceased work at the close of navigation that year, and have not resumed operations.

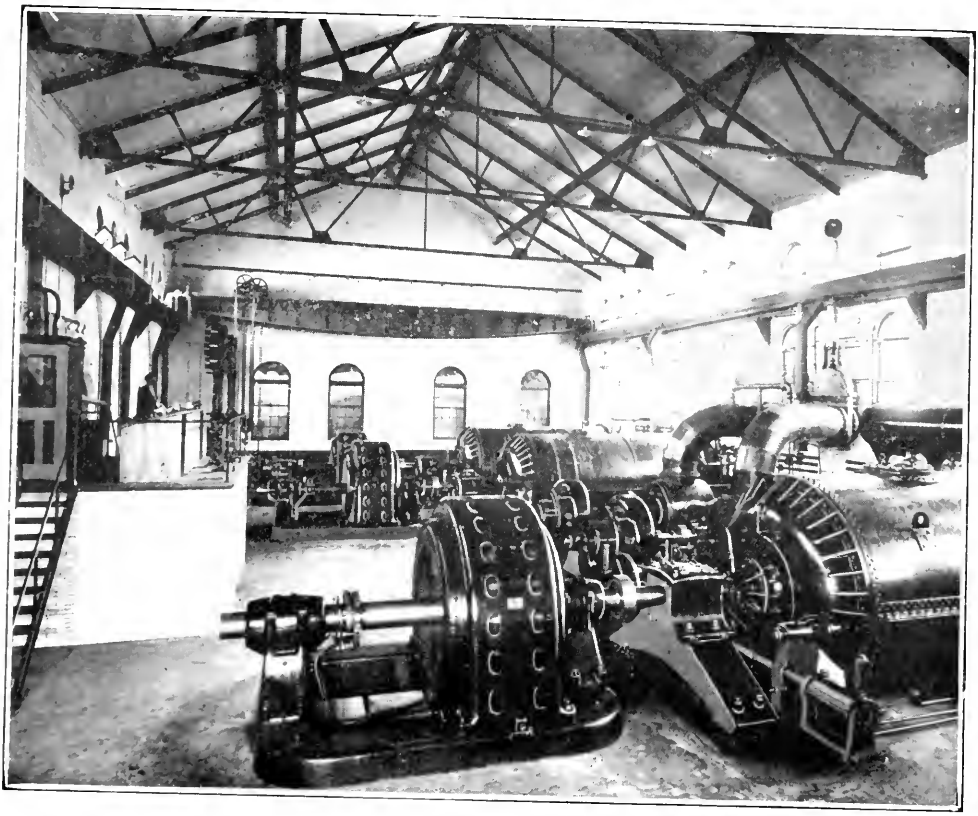
Port Arthur Silver Mines

Very little work was done at these mines in 1910. The West End Silver mine was in operation for a time with a few men, continuing the drifts east on the third and fourth levels of No. 2 shaft. The West Beaver and the Climax were also operated for a short time. Work is being done on an island about 30 miles southwest of Port Arthur under the direction of Mr. R. A Lockerby, for a Montreal syndicate. A shaft was sunk on a calcite vein a depth of 50 feet and work continued during the winter.

II.—SUDBURY AND THE NORTH SHORE

The production from the Sudbury Nickel mines shows again an increase over the preceding year. This production comes altogether from the mines operated by the Canadian Copper Company and the Mond Nickel Company. The output of the

Canadian Copper Company in 1910 came from the Creighton, Crean Hill and No. 2 mines. A considerable amount of diamond drilling was done at No. 3 mine, and the company state that a large body of ore was located. The production of the Mond Nickel Company was obtained from their Garson and Victoria mines. The Dominion Nickel Copper Company have completed their spur from the mine to the railway, built their rock-house, installed machinery and begun mining. The Moose Mountain Mines, Limited, completed their large magnetic concentration plant in May, 1910, and shipped steadily during the season of navigation. It is now proposed to double the capacity of this concentrator. Shipments from the Helen iron mine at Michipicoten were continued steadily during the season of navigation. The Lake Superior Corporation are



Interior of power house, Huronian Power Company.

developing a property about 18 miles northeast of the Helen, called the Magpie. A branch of the Algoma Central, 9 miles in length, is being constructed to the property, which has been systematically diamond-drilled. A shaft is now being sunk.

The gold properties at Michipicoten are all idle. A number of claims have been staked for gold near Hobon during the winter, but no development work has yet been done on them. The Algoma Central railway is being built north from the Sault to connect with the main line of the Canadian Pacific railway at Hobon. This will give access to a mineralized area that has heretofore been inaccessible.

Canadian Copper Company

The Creighton and Crean Hill nickel-copper mines were worked all year, and No. 2 mine part of the year. The output in 1910 was the largest on record. No. 3 deposit,

about three miles north of Copper Cliff, was diamond-drilled during the year and the company report that a large tonnage of ore was blocked out.

The officers of the company remain unchanged. Mr. A. P. Turner is president and general manager, Mr. John Lawson, general superintendent, and Mr. D. H. Browne, metallurgist.

Creighton Mine

The east end of the ore body has been open-cut to the third level. As the deposit dips to the north, it was found that at the depth of the third level considerable ore had to be left in the hanging wall; besides, the perpendicular wall was difficult of access for scaling. As a result the company decided to take down the overhanging rock on the hanging wall. To facilitate the handling of this waste rock, a cableway was stretched across the open pit, and the rock taken out by means of buckets operated from this cableway. The west part of the ore body above the third level has not been removed, and the stope is partially filled with ore. On the fourth level Nos. 1 and 2 shafts are connected underground, and the ore is mined from the easterly portion of the workings by overhand stoping but not filling. Large pillars are left at neces-

Roast yards, Canadian Copper Company.

sary intervals. In the westerly part of the stope on this level the filling system inaugurated at the Crean Hill mine is used. Drifts are first driven through the ore body and then widened to the walls, leaving pillars where necessary. Slices are then taken off the roof until it is sufficiently high to commence building the dry walls. These dry walls are built by masons and covered with heavy lagging, so that tramways are maintained. At the necessary intervals, ore chutes and manways are carried up in the walls. These are circular in form. The ore is then broken down by back stoping, and the surplus drawn off from the chutes where necessary. At the Creighton, the filling is ore, which has the advantage of always maintaining a large reserve of broken ore in the mine. An air-operated gate, designed by Capt. Lawson, is used to control the flow of ore from the chutes while filling the tram cars.

A new electric-driven compressor has been installed at the second level station of No. 2 shaft. The installation of a compressor underground is a new departure in Ontario. The intake pipe for the compressor is carried down the ladderway of the shaft.

Mr. Wm. Hambly is superintendent at the mine.

Crean Hill

The filling system is used at this mine at all the levels except the second, which is an open cut to the surface. The system differs from that employed at the Creighton, in that waste rock is used for filling and the ore is sorted underground.

Work in December, 1910, was being carried on, on the second, fourth, fifth and sixth levels. From the open pit on the second level some tramming was being done. On the fourth level the filling is about 40 feet above the level. The stope here is about in the form of an equilateral triangle, with each leg 320 feet in length. On the fifth level the fill is about 24 feet above the level. On the sixth level the dry wall has been started on the south wing of the ore body. On the other parts of the level the ore body is being cut out preparatory to beginning the dry wall.

Mr. M. Pickard is superintendent at the mine, employing 150 men.

No. 2 Mine

No work was done in this mine between 1907 and 1910. The shaft is 500 feet in depth to the sixth level. The company were working on the fifth and sixth levels. On the fifth, the ore, which had been broken down from the fourth level floor, making an open cut to the fifth level, was being trammed out. On the sixth level a force was engaged cutting a section of the ore body and back stoping. Mr. J. Ovens is superintendent. The old rock-house has been remodelled, so that the ore is dumped directly into the crusher and then passes over picking belts to the bins. The power house has a compressor and a hoist, which are duplicates of those at the Crean Hill and the Creighton.

Quartz Quarry

In the township of Dill on the Canadian Northern railway, quartz for use at the smelters is mined. About 300 tons a day are shipped. This is all taken out by open-cut work; hoisting is done by derrick. About 45 men are employed.

Smelting Works

The most marked change on which work has been in progress during the last year at the smelter is the building of a reverberatory furnace. Construction work has been going on for some months. The furnace is being erected at the north end of the present smelter building. The other furnaces were in operation throughout the year with increased output. A new basic converter with largely increased capacity has been installed. This basic converter is the largest in use on the continent.

Cobalt Silver Refining Plant

This plant has been enlarged to treat 800 tons of ore per month. A silver refinery and a plant for producing cobalt-nickel hydrate have been installed. The company now ship refined silver, arsenic, and cobalt in its marketable form, there being no demand for refined cobalt. The cobalt-nickel hydrate will be shipped to the European market.

Mond Nickel Company

This company shipped steadily during the year from their Victoria and Garson mines to their smelter at Victoria mines. The second unit of their power plant at Wabageshik falls has been installed, so that the company have two units of 1,200 kilowatts each at 80 per cent. power factor.

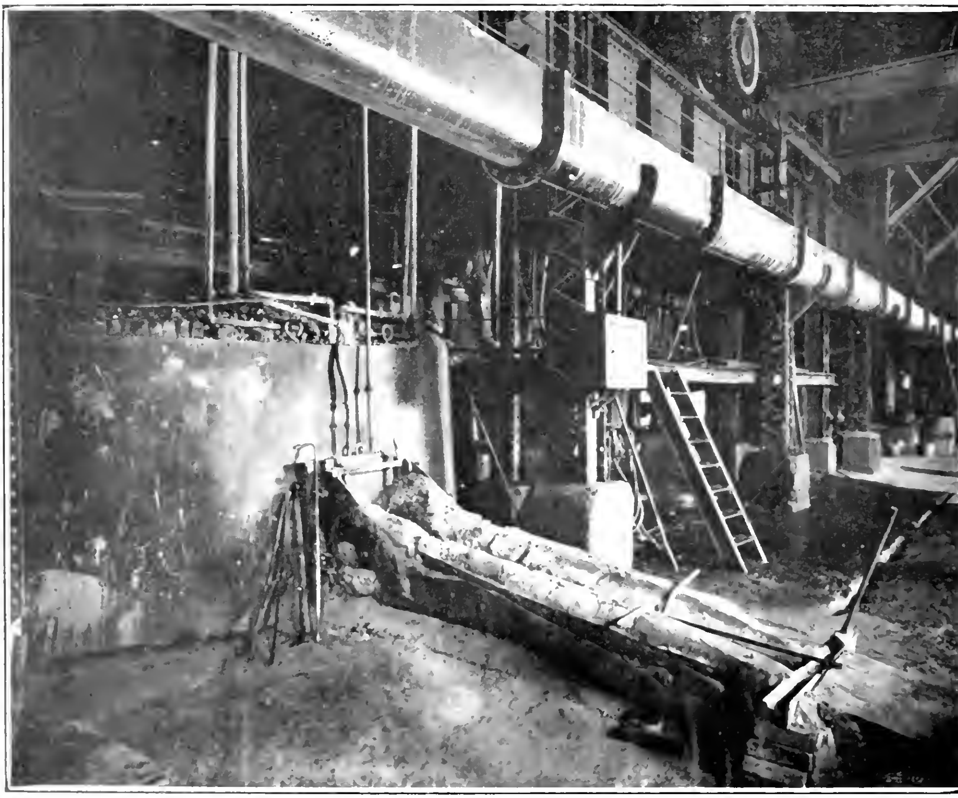
The officers of the company are Mr. C. V. Corless, manager, and Mr. O. Hall, mines superintendent.

Victoria Mines

The main shaft at this mine is now 1,360 feet in depth, the deepest in the Province. The company are working on the fifth, eighth, ninth, tenth and eleventh levels, the other levels having been abandoned. On the fifth level an exploratory drift is being

driven east. On the eighth level the work of cutting out a branch of the west ore body is in progress. On the ninth, the upper section of the 150-foot west ore body is being stoped out, and the east ore body between the eighth and ninth levels has been broken down and is being trammed out. On the tenth a winze has been sunk to connect with a raise from the eleventh level, and the lower section of the ore body is being stoped out. A section has been cut on the east ore body on this level and a raise put up about 30 feet. On the eleventh level the work of tramming ore from the west stope, lower section, is in progress. A section is being cut on the east ore body. The ore bodies between the three lower levels are being taken out in two sections each, on account of the levels having been run 150 and 200 feet apart. The ore is taken by aerial tram from the mine to the roast yards about one mile distant.

About 100 men are employed at the mine.



Settlers of Furnace, Canadian Copper Company.

Garson Mine

The main shaft at this mine is 700 feet in depth, with levels every 100 feet. On the first level stoping is being carried on in the northeast or No. 14, and the northwest or No. 15 stopes. On the second level ore is being taken from stopes Nos. 21 and 26. These stopes have been connected by raises with the first level, and raises have been put through from the first level to the surface. On the third level drifts have been run to the several ore bodies and some stoping done. Very little work is in progress on the fourth and fifth levels. On the sixth level a drift has been run southeast on the ore, a distance of 300 feet from the shaft. On the seventh level the station has been cut.

Mr. A. Sharp is mine superintendent, employing 250 men. The ore is shipped by Canadian Northern railway to Sudbury, and then by the Sault line to the smelter at Victoria Mines.

Smelter

Both furnaces at the smelter are in operation the greater part of the time. Ore is brought by aerial tram from the roast yards about one mile distant. About 50 per cent. of green Garson ore is used in the furnaces. The company have worked out and used successfully a treatment by which the converter slag is poured directly back into the furnace settler, thus saving the cost of re-smelting the slag. A new site for a smelter has been secured near Romford and plans for a new smelter there are being prepared.

Some 200 men are employed at the smelter.

Dominion Nickel-Copper Company

This company have completed their branch line from the Canadian Northern to the mine, and have purchased a locomotive and cars for operation thereon.

A rockhouse has been erected and an 18 x 36-inch jaw crusher driven by two motors of 75 h. p. and 40 h.p. capacity installed. Electric power is obtained from the Wahnapitae Power Company. A power house has been erected and an 1,800-foot compressor driven by a 300 h.p. motor installed. The transformer house is built of concrete.

Mining operations have begun, the ore being mined by open cut work. Mr. J. N. Glidden is in charge, employing a force of 50 men.

Iron

Moose Mountain Mine

An output of about 500 tons of concentrates a day was shipped during the season of navigation to Key Harbor. The ore was mined chiefly by open cut method. The open pit in November, 1910, was about 200 feet wide and 125 feet long, with a face about 65 feet in height. An adit was driven 25 feet below the bottom of the open pit, opening up a stope 75 feet wide. One side of this was broken through to the open cut level. A three-compartment shaft has also been sunk a depth of 100 feet.

The ore is trammed from the open pit and dumped into large pockets, from which it is fed into a series of crushers which reduce the product to 1-inch or under. A belt conveyor then carries it to the mill, 300 feet south, where it is passed over a series of magnetic concentrators. The concentrates are then carried by belt conveyors to a bin over the railway tracks. From this bin it is dumped into cars. The tailings are also carried away by belt conveyors. The whole process of concentration is by the dry method.

Instructions were given regarding the work in the open pit, the fencing of machinery and the thawing of explosives.

Mr. Fred A. Jordan is manager, employing a force of 200 men.

The ore docks at Key Harbor, from which the ore is shipped, have been described in former Reports of the Bureau of Mines.

Michipicoten Area

Mining work in this area during 1910 was confined almost entirely to iron. A little work was done at the Norwalk and Kitchegammi gold mines, but all operations had ceased at the date of my inspection. During the fall and winter a number of claims were staked for gold near Hobon, in township 19, range 27. Little work has as yet been done on these claims, so that the importance of the discoveries has not been ascertained.

Helen Iron Mine

This mine, owned and operated by the Lake Superior Power Company, is the only important producer of hematite in the Province. The production from this mine in 1910 was considerably below that of 1909. This was due to the delay in getting the stopes

Algoma Central Railway. Laying steel near Magpie iron mine.

Magpie iron mine, 1910.

on the sixth level of the mine opened up. As a result large shipments from the mine were not begun till August. From this time until the close of navigation the mine produced about 1,000 tons per day. Iron pyrites was also shipped from the mine, being obtained from beyond the easterly limit of the iron ore on the fifth level of the mine. This body is also being developed on the sixth level.

No. 2 shaft has been enlarged below the sixth level into a 4-compartment shaft and sunk to the eighth level, a vertical depth of about 600 feet. No. 1 shaft is not being sunk any deeper, owing to the nature of the ground that was encountered in the bottom of the shaft. On the seventh level the station has been cut and the work of developing the ore body begun. This will be blocked out similarly to the other levels, by driving a main drift down the centre of the ore body, and then cross-cutting right and left alternately, at an angle of about 50 degrees from the main drift. From these cross-cuts raises are put up at 30-foot intervals. The ore taken out in development work during the winter is hoisted to the upper levels and dumped into worked-out stopes. From these stopes it is drawn when shipping begins at the opening of navigation.

During the winter the work of exploring under Boyer lake has been carried on. To accomplish this drifts are run on the third, fourth, fifth and sixth levels northwesterly under the lake.

New electric pumps have been installed underground and a new dry-house erected near the mouth of No. 1 shaft.

Mr. R. W. Seelye is manager, and Mr. A. Hasselbring superintendent, employing 200 men.

The company use electric power entirely at the mine. The steam plant is kept in reserve, as also the steam pumps, to be used in case of emergency.

Magpie Iron Mine

In township 54, range 26, the Lake Superior Power Company are carrying on important development work on a deposit of siderite and magnetite. The deposit was systematically diamond-drilled during 1910 and the work of sinking a shaft begun. The shaft has four compartments and was, in February, 1911, 115 feet in depth. A straight-line compressor, 125-h.p. boiler and hoist have been installed.

As soon as the railway branch is completed to the mine, permanent camps will be constructed and a plant installed. It is proposed to build roasting furnaces at the mine to treat the ore, which is somewhat sulphurous.

Diamond drilling is being done on the Alice claims one-half mile southeast from the Magpie, and at Iron lake south of White river.

Mr. A. Scott is superintendent, employing 85 men.

III.—TEMISKAMING

A full description of the cobalt-silver mines of the Temiskaming district is given in the fourth edition of Dr. W. G. Miller's Report on the Silver Region of Northern Ontario, which is published as Part II. of the Nineteenth Report. This includes an account of the working mines at Cobalt, South Lorrain, Montreal River and Gowganda. It is, therefore, unnecessary to refer to these mines in this Report.

Porcupine Gold Area

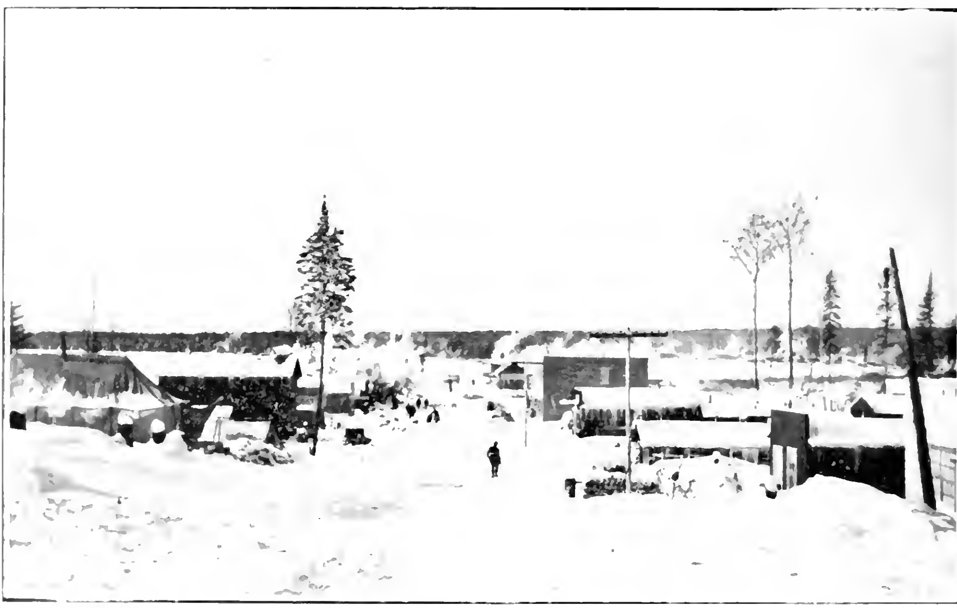
A great deal of interest has been shown during the year in the new gold camp at Porcupine. It is at present the most active camp in Canada. Cobalt has settled down to a steady producer, so that Porcupine, being in the development stage, provides a field for investors and speculators from all over the world. The Dome and Hollinger are the two properties on which any considerable development work was done in 1910. During

the present year, however, a number of other companies have installed plants and commenced underground work. As is usual in a boom camp, a large number of companies have been formed and stock sold to the public on properties on which practically no development work has been done. The Temiskaming and Northern Ontario railway expect to have the branch line from Mileage 224½ on the main line to Porcupine lake completed by July 1st, 1911. The completion of the line will give much-needed access for supplies to the different companies operating there.

The following properties were inspected in April, 1911. Their location can be seen by referring to the map of the Porcupine area accompanying the Report of Mr. A. G. Burrows in Part II. of this volume.

Crown Chartered

On the northeast quarter of the south half of lot 2 in the fifth concession of Tisdale, the Crown Chartered Mining Company have sunk a shaft a depth of 60 feet and cross-cut



Porcupine, Government townsite, March, 1911.

north from the shaft 100 feet. Some trenching has also been done on the claim. The plant consists of a 50-h.p. boiler, 2-drill compressor, hoist and sawmill.

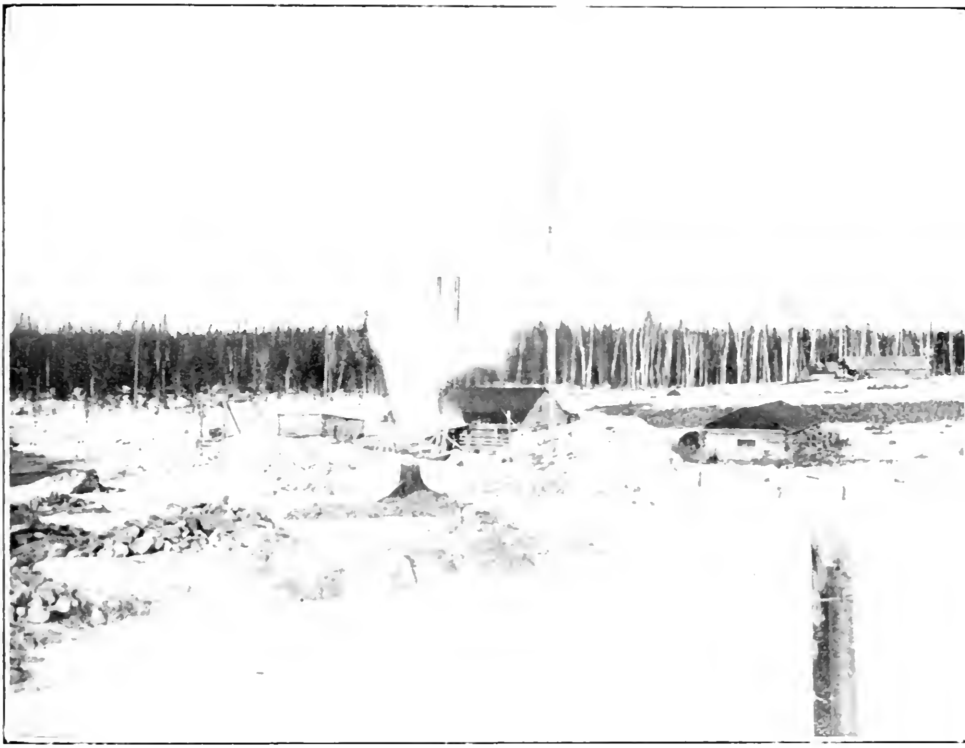
The company also own a claim adjoining the Vipond. During the winter work was begun on this claim and a shaft sunk about 50 feet.

Dobie

On the north half of the south half of lot 1 in the fifth concession of Tisdale, the Dobie Mines, Limited, have sunk a shaft a depth of 100 feet. Some diamond drilling has also been done. These claims were formerly known as the Armstrong-McGibbon.

The plant consists of one 60-h.p. boiler, one 20-h.p. upright boiler, one straight-line compressor and one hoist.

Mr. C. A. Watson is manager.



Dome mine, March, 1911.

Dome, machinery for new mill.

Dome

On the north half of lot 4 in the first concession of Tisdale, the Dome Mines, Limited, energetically carried on underground development work during 1910. Four shafts were sunk to a depth of about 75 feet, 50 feet, 50 feet, and 50 feet respectively. No. 1 shaft and No. 2 shaft, 200 feet west of it, have been connected by a cross-cut at the 40-foot level. Sixty feet east of No. 2 shaft a drift has been run north 75 feet and south 150 feet. A raise was put through to the surface at the end of the south drift. A number of other drifts and cross-cuts were run.

The plant during 1910 consisted of two 60-h.p. boilers, four upright boilers, a 4-drill compressor, four hoists and one Nissen stamp for sampling. During the winter a new power plant was taken in and is being erected. Excavation has been completed for the installation of a 40-stamp mill. This mill was designed and is being erected by the Merrill Metallurgical Company. Preliminary crushing will be done by two gyratory crushers. The ore is then conveyed by belt conveyors to the forty 1,250-pound stamps, crushing to about 8-mesh. It is proposed to adopt a preliminary amalgamation of this product. It then goes to Dorr classifiers, and then to tube mills, followed by a second set of amalgamating plates. The pulp is then led into classifiers, then Dorr thickeners, and then to Pachuco agitating tanks. From the tanks the product is passed through Merrill filter presses. The gold from the solution will be precipitated by the Merrill zinc dust process. It is intended that the mill shall be in operation during the present summer; it is to be motor driven throughout.

Mr. R. M. Meek is manager.

Dome Extension

This property is situated northeast of the Dome and adjoining it.

A small plant was taken in during the early part of 1911, consisting of a boiler, compressor and hoist.

The work is in charge of Capt. Anchor.

Foley-O'Brian

Northeast of the Dome Extension and about one-half mile west of Porcupine lake, the Foley-O'Brian Mining Company have been carrying on development work. A shaft has been sunk a depth of 150 feet and a small boiler and hoist installed. Mr. Mowry Bates is in charge of operations.

A plant consisting of two 50-h.p. boilers and a 5-drill compressor and hoist has been installed.

Hollinger

The Hollinger Gold Mines, Limited, own the four claims consisting of the east half of the north half, and the northeast quarter of the south half of lot 11, and the northwest quarter of the south half of lot 10, in the second concession of the township of Tisdale. Work was started on these claims early in 1910 and has been prosecuted vigorously since that time. No. 1 and No. 3 shafts are 650 feet apart and have been sunk 100 feet. These shafts have been connected by a drift on the vein. A drift has been run north of No. 1 shaft on the vein about 400 feet and south from No. 3 shaft 150 feet. At the north end of the main drift cross-cuts have been driven east and west 100 feet. About 110 feet south of No. 1 shaft a cross-cut has been driven 140 feet to a parallel vein. A cross-cut is also being driven west from No. 3 shaft. At 100 feet north of No. 1 shaft a winze has been sunk 100 feet, and 30 feet of drifting done at that level. It is now proposed to raise a central 4-compartment shaft as a main working shaft.

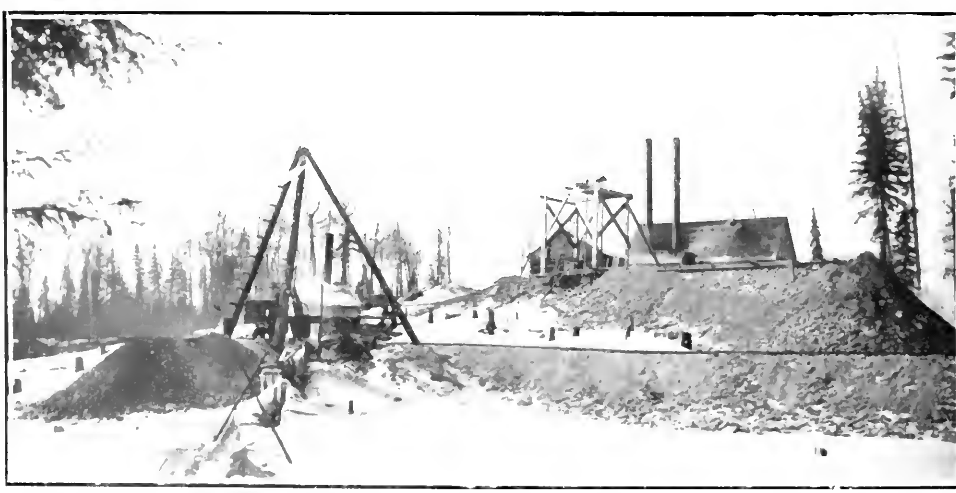
The plant installed in 1910 consisted of two 60-h.-p. return tubular boilers, 1 6-drill compressor, two hoists, an electric light plant and two Tremaine stamps.

The new plant consists of an electrically driven compressor having a capacity of 1,500 cubic feet of free air per minute, and an electric hoist. A 30-stamp mill is being erected. The cyanide plant will not be installed at present. The treatment at first will consist of crushing the ore by means of jaw crushers, and then by the thirty 1,500-pound

Dome, new power house, dining hall in distance.

Dome, foundation of stamp mill.

Foley-O'Brian Mine, Porcupine.



Foley-O'Brian Mine.

stamps, amalgamating and concentrating. As soon as transportation facilities allow, tube mills and a complete cyanide process will be installed.

The concentrating will be accomplished by Overstrom tables and Frue vanners. The mill will be erected about 200 feet west of No. 1 shaft.

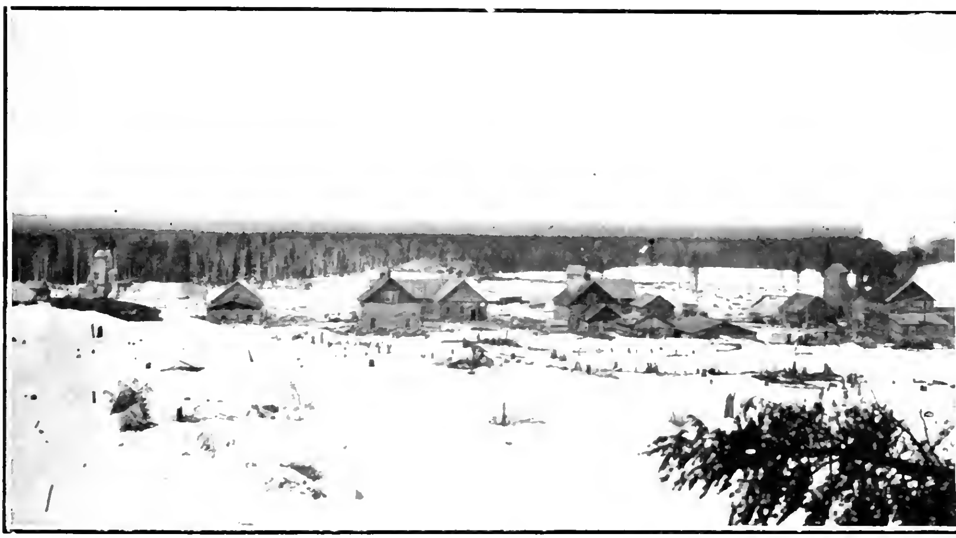
Camp buildings have been erected for the accommodation of 250 men. All the machinery at the mill will be driven by electricity delivered by the Porcupine Power Company.

Mr. P. A. Robbins is general manager.

Porcupine Power Company

At Sandy Falls on the Mattagami river, about six miles northwest of the Hollinger, the above company are constructing a hydro-electric power plant for the supplying of electric power for use at the mines at Porcupine.

A timber dam about 800 feet long has been built across the river. This will raise the water about 13 feet and will give an effective head of water of 34 feet. Water is



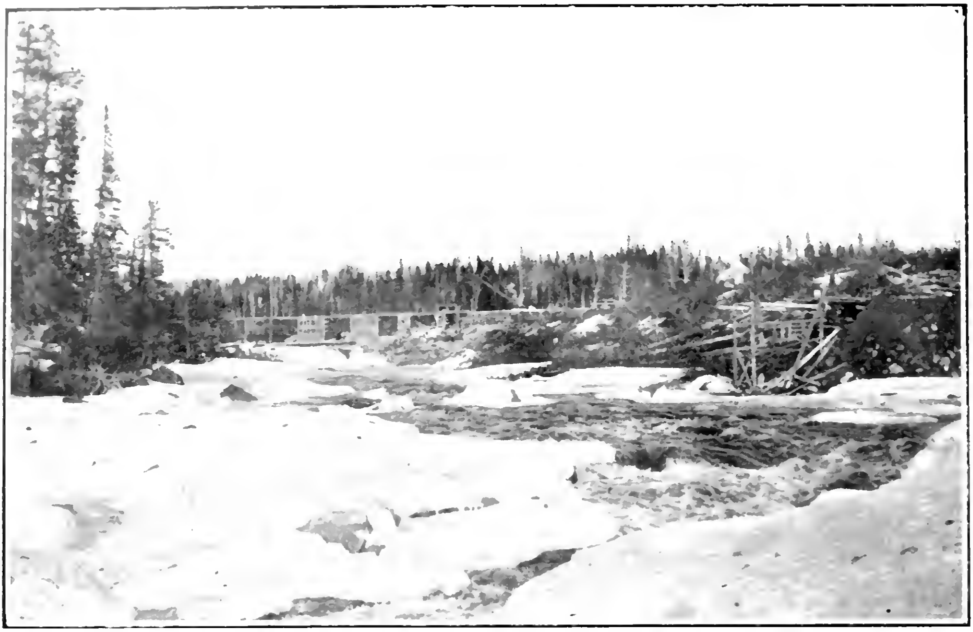
Surface plant of Hollinger mine, April, 1911.
(Destroyed by fire, May 1911).

led from the intake at the dam to the power house by a flume 16 feet by 16 feet. The present installation will consist of two units, each unit comprising a pair of twin water-wheels directly connected with a 3-phase, 25 cycle, 1,250-kilowatt generator. The power will be transmitted to the mines at a pressure of 12,500 volts. The transmission line will consist of two independent 3-phase circuits of aluminium conductors carried upon a single line of poles.

The power house is a frame structure covered with galvanized iron. The superintendent in charge of construction, Mr. H. D. Symmes, expects to be delivering power in June, 1911.

Northern Ontario Exploration Company

This company was formed by Bewick, Moreing and Company to take over fifty claims from the Timmins-McMartin-Dunlap syndicate, agreeing to provide a working capital of half a million dollars for developing the claims. These claims are situated chiefly in the townships of Tisdale, Whitney and Deloro. The company have constructed four camps, and sufficient supplies have been brought in for the employment of 150 men during the summer A headquarters camp has been established near Pearl lake.



Dam of Porcupine Power Company, looking up stream.

Dam of Porcupine Power Company, looking down stream.

Pearl Lake

The Pearl Lake Gold Mining Company have begun work on claims just east of Gillies lake. A small plant has been installed and two shafts started.

Preston East Dome

This property lies to the southeast of the Dome and adjoining it. Camps were erected and a plant brought in during the winter. Practically no mining had been done on the property.

Mr. S. Thorne is in charge of operations.

Rea

The Rea Consolidated Mines, Limited, are working on the south half of lots 5 and 6, in the fourth concession of Tisdale. A shaft has been sunk a depth of 200 feet, and on the 100-foot level a cross-cut driven 20 feet north and south. Another shaft about 150 feet west on the same vein has been sunk to a depth of 60 feet.

A plant consisting of two 60-h.p. boilers, a 6-drill compressor and hoist has been installed.

Mr. Kingsmill is in charge of operations.

Scottish Ontario

On the southeast quarter of the south half of lot 11, in the fifth concession of Whitney, the Scottish Ontario Gold Mining Company have sunk a shaft a depth of 90 feet. A cross-cut has been driven from the shaft south 20 feet and north 100 feet. In the north cross-cut the vein was cut and 50 feet of drifting done on it. A 20-h.p. boiler and hoist have been installed.

Mr. Peter Maclaren is manager.

Standard

About two miles south of Porcupine lake in the northern part of Deloro, the Standard Silver Mines, Limited, have sunk a shaft a depth of 50 feet. A 20-h.p. boiler and hoist have been installed.

Mr. L. P. Silver is in charge of operations.

West Dome

On the Hotchkiss claims adjoining the Dome on the west, the West Dome Mines, Limited, are sinking a shaft. This shaft was about 25 feet in depth. A power plant consisting of two 60-h.p. boilers, a 6-drill compressor and hoist has been installed. Several holes have been put down with a shot drill to test the veins at depth.

Mr. R. A. Weiss is superintendent in charge.

Vipond

On the southeast quarter of the south half of lot 10 in the second concession and the northeast quarter of the north half of lot 10 in the first concession of Tisdale, southeast of the Hollinger, the Porcupine Gold Mines, Limited, have sunk a shaft a depth of 100 feet. A cross-cut was driven 50 feet east to the vein and drifts run on this vein 60 feet north and south from the cross-cut. On another vein a shaft was sunk 40 feet.

The plant consists of a 40-h.p. boiler, a small compressor and hoist. A Nissen stamp was put in operation about the first of the year.

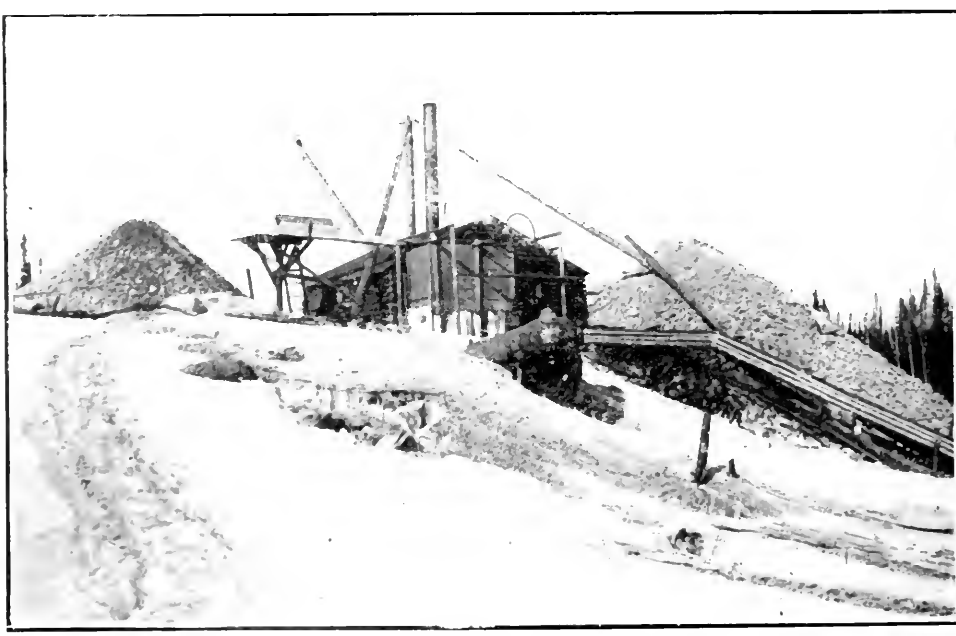
Mr. C. H. Poirer is superintendent.

Swastika Area

Swastika Gold Mine

The Swastika Gold Mining Company hold nine claims near Swastika station, Temiskaming and Northern Ontario railway. The three original claims are situated on the shore of Otto lake, two adjoining on the south in Otto township, two to the north in unsurveyed territory, and two in lot 9 in the fourth concession of Otto.

Rea Mine.



Scottish Ontario Mine.

The main shaft has been sunk 100 feet below the adit level. The adit level is at a depth of 40 feet, and some 400 feet of drifting has been done on this level. On the 100-foot level considerable drifting and cross-cutting have been done. From this level a winze has been sunk on the vein a depth of 90 feet. In all over 1,000 feet of development work has been done.

The plant consists of a 60-h.p. boiler, compressor and hoist. A 5-stamp mill has been erected and is being run steadily.

Mr. A. T. Bell, of Tavistock, is president of the company, and Mr. J. W. Vandergrift superintendent, employing a force of 32 men.

Munro Township

On a number of properties in the townships of Munro and Guibord, mining work was carried on for gold during 1910. The only property on which anything was being done in April, 1911, was the Detroit and New Ontario.

Detroit and New Ontario

On this property a shaft has been sunk a depth of 80 feet. The plant consists of two 50-h.p. boilers, 6-drill compressor and hoist. Mr. G. M. Morin was in charge, employing 11 men.

American Eagle

On this property no work has been done in 1911. One shaft has been sunk 30 feet and some surface prospecting done. The plant consists of two 50-h.p. boilers.

Gold Pyramid

On this property, situated in Munro, a shaft has been sunk 25 feet, but no work done in 1911. The plant consists of two 50-h.p. boilers.

Munro

The Munro Mining Company ceased work in August, 1910. A shaft had then been sunk 90 feet. A 30-h.p. boiler and hoist were used in doing this work.

Temagami Area

Very little mining was carried on in this area in 1910. The Northland pyrites mine was in operation the first part of the year, but work was stopped in July and has not since been resumed. The work done, other than that described in the last Report, consisted of stoping between the second and third levels.

Larder Lake Area

An inspection of this area was made in August, 1910, by Inspector Robinson. He found very little mining work in progress. The Gold Fields, Limited, generally known as the Harris-Maxwell, were engaged sinking a shaft on the top of the hill above the lake. This shaft was 25 feet in depth and the equipment used was boiler, hoist and derrick.

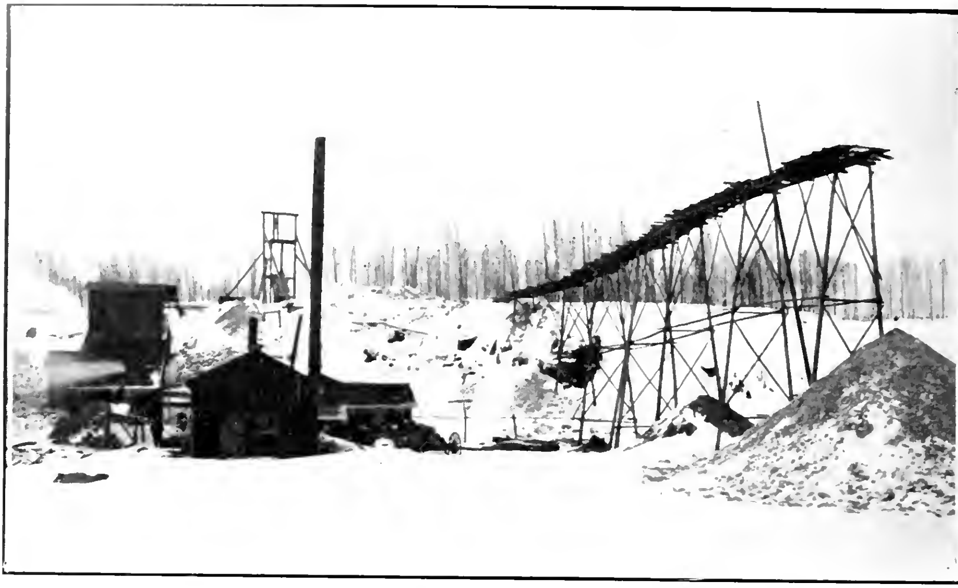
Mr. B. T. Brooks was in charge of operations, employing 11 men.

No mining work was being done at the property owned by the Victoria Creek Gold Mines, Limited, but it was pumped out and open for examination. It was found that a shaft had been sunk a depth of 150 feet and 360 feet of drifting done at the 100-foot level.

The plant consists of a 50-h.p. boiler, a 2-drill compressor and hoist.

Mr. W. T. Mason, of Montreal, is president, and Mr. G. Eggleston superintendent.

On a number of other properties small gangs were engaged in doing assessment work.



Swastika Mine.

Detroit camp, Munro township.

Canadian Exploration Company

This company worked continuously during the year at the Long Lake mine in township 69, about nine miles south of Naughton. A mill was erected and was in operation part of the year. At the mill the ore is crushed in a 10-stamp mill and re-ground in a tube mill. The pulp is then subjected to cyanide treatment without preliminary amalgamation.

The first level of the mine is at a depth of 76 feet. From the shaft a cross-cut has been driven east 90 feet and a main drift run north and south on the ore body, a total length of 230 feet. From this main drift cross-cuts have been driven at intervals and short drifts to connect the cross-cuts. Four raises have been put up and a winze sunk from this level.

Mr. R. W. Brigstocke is manager.

IV.—EASTERN ONTARIO

Eastern Ontario continues to produce a variety of minerals. The mining of gold was at a very low ebb in 1910. The old Belmont mine has recently been purchased by new interests, and it is expected work will be resumed in 1911. The minerals produced in this area productive of largest returns are corundum, iron pyrites, mica, graphite, feldspar and talc. In addition to these, marble, building stone and limestone for cement purposes created large industries in the respective centres in which they were being raised.

Eastern Ontario feldspar holds a very prominent place in the United States market. This feldspar is practically all shipped in its crude state to Trenton, N.J., and East Liverpool, Ohio, where it brings as high a price as any spar on the market. A sample of ground spar from the Richardson quarry, taken from the bins at the mill of the Eureka Flint and Spar Company, Trenton, N.J., gave the following analysis:[1]

	Richardson spar.	Pure spar (theoretical).
Silica (SiO_2)	65.87	64.7
Alumina (Al_2O_3)	19.10	18.4
Lime (CaO)	.20	
Potash (K_2O)	12.24	16.9
Soda (Na_2O)	2.56	
Water (H_2O)	.64	
Total	100.61	100.00

The prices of feldspar in general are as follows at Trenton, N.J., f.o.b. mills:

	Crude, per long ton.	Ground, per short ton.
No. 1 Canadian	$5.50	$10.50
No. 2 or "Standard"	$5.00-$5.25	$9.00-$9.50

Feldspar is extensively used by the manufacturers of pottery, enamel ware, enamel brick and electrical wares. The trade demand that for these purposes the spar shall be practically free from iron-bearing minerals such as biotite, hornblende, iron pyrites, etc. The No. 3 spar, having an approximate analysis of 76 per cent. silica, 13 per cent. alumina, 5.5 per cent. potash and 3.5 per cent. soda, is used for poultry grit and roofing purposes. The price of this material in northern New York state, ground, is from $3.00 to $3.50 per ton. There is no production of this grade in Ontario. There is no mill for grinding feldspar in Ontario, and it is all shipped in its crude state as taken from the

[1]Bulletin No. 420, U.S. Geol. Survey.

mines. The states of Connecticut, Pennsylvania and Maryland are the principal producers of feldspar in the United States. Ontario feldspar is, however, handicapped by the long rail haul to Trenton and East Liverpool. The establishment of some branches of the pottery and enamel ware industries in Ontario, where we have all the raw material necessary, should be looked upon as a possibility in the near future.

As with feldspar, most of the mica produced in Ontario is shipped to the United States. Up to the present time the crude mica has been cleaned and thin-split here, furnishing employment to 1,000 or 1,500 people.

Small quantities of apatite continue to be produced from mines worked for mica. The outlook for better prices for this mineral is, however, not very assuring in view of the large beds of phosphate discovered in Utah, Wyoming and Idaho, and the considerable production from Florida.

The ground talc industry at Madoc has been steadily growing, the production being nearly double in 1910 that of 1909. There was also a marked increase in the production of graphite.

Electric power is largely used at the mines and quarries of eastern Ontario. The Seymour Power and Electric Company are supplying a number of producers both at the mines and quarries. The Lehigh plant of the Canada Cement Company near Belleville is using about 3,000 h.p. furnished by this company and the Point Anne Quarries, Limited, about 300 h.p.

About 2 miles south of Bancroft the Ontario Marble Quarries, Limited, are opening up a marble quarry.

Iron Ore

The Mayo mine, operated by the Canada Iron Corporation under lease from the Mineral Range Iron Mining Company at Bessemer, was closed in May, 1910, and no work has since been done at it.

The old Wilbur mine near Lavant on the Kingston and Pembroke railway was re-opened after having been closed down for about two years.

About one mile northeast of Madoc, Mr. G. A. Longnecker was engaged in developing an iron claim. Considerable trenching and testpitting was done and a shaft sunk 35 feet. A diamond drill was also in operation.

Wilbur

This mine is being operated by the Exploration Syndicate of Ontario. No. 1 shaft worked by the last operators has been re-opened, as also an old shaft northwest of No. 1. At No. 1 the depth remains the same, the work consisting of stoping on the different levels that have not been worked out and running exploratory drifts on the lower levels. At the other shaft, which is about 80 feet deep vertically, the work of re-timbering was about to begin. This shaft had not been worked for about 20 years, so that it was necessary to re-timber all the workings.

A new crusher and ore bins have been erected at No. 1 shaft. The present plant consists of three 80-h.p. boilers, two compressors, both straight line, engines and crushers. This plant is to be supplemented by a new plant at No. 2 shaft consisting of boilers, compressor and hoist. New camp buildings have been built.

Mr. J. G. McNulty is in charge, employing 100 men.

Iron Pyrites

Sulphide

Considerable change and improvements have been made at this mine during the year. The new shaft mentioned in the last Report has been completed. This shaft is situated about 300 feet east of the old shaft and extends to the fifth level, the

lowest level of the mine. As the old shaft extended only to the third level, the work while the new shaft was being completed was all above this level, and consisted chiefly of stoping on the second and third levels north vein. A head frame has been erected over the new shaft containing a sorting and breaking floor and ore pockets. An electric hoist has also been installed at this shaft. The motive power at the mine and works is now all electric, obtained from the Seymour Power and Electric Company.

The building for the manufacture of hydrochloric acid has been completed and all the machinery installed. Machinery has also been installed for doubling the capacity of the other parts of the acid plants.

Mr. W. H. DuBlois is superintendent in charge for the owners, the Nichols Chemical Company.

Craig

At the Craig property just west of Sulphide, the shaft is now at a depth of 250 feet with levels at 100 feet and 200 feet. On the first level, drifts have been run east and west 80 feet and 85 feet respectively, and stoping has been begun in each.

On the second level, the east drift is in 75 feet from the shaft, and the west drift 25 feet. The ore taken out is being sold to the Nichols Chemical Company at Sulphide.

The plant consists of two upright boilers, a straight line compressor and hoist.

Queensboro

On the northeast quarter of lot 9 in the tenth concession of Madoc, the property formerly worked by the Canadian Pyrites Syndicate, the Canadian Sulphur Ore Company are developing an iron pyrites property. The shaft is 75 feet in depth, with short drifts on the ore and some stoping done. Two other shafts have also been sunk to a depth of 75 feet and 50 feet.

The plant consists of an 80-h.p. boiler, a 4-drill compressor and hoist.

Mr. S. N. Graham is superintendent.

About one-half mile from this property Mr. M. J. O'Brien is also developing a deposit of iron pyrites. Several tests pits have been sunk.

Zinc Ore

Olden

This was the only zinc mine in operation in Ontario in 1910. Work was confined altogether to the pit on the new vein northwest of the old workings. This pit is now 50 feet in depth and about 75 feet in length.

The mine is owned and operated by Messrs. Richardson of Kingston, and was closed down late in 1910.

Feldspar

Richardson Mine

The Kingston Feldspar and Mining Company shipped steadily during the season of navigation. This mine is the largest shipper of feldspar in either Canada or the United States. It is worked as a large open pit, the dimensions of the workings being about 500 feet in length, 200 feet in width and 130 feet in depth measured from the highest point of the wall. Hoisting is done by means of a cableway across the widest part of the pit and by a derrick at the northwesterly end. At the central part of the pit, quartz occurs as a capping over the feldspar. Work at removing this quartz was in progress during the winter. It is shipped to Welland, where it is used in the manufacture of ferro-silicon. It was also proposed to take off the capping of gneiss that occurs on the north side of the pit for a distance of 20 to 25 feet. This capping is from 10 to 20 feet in thickness, with good feldspar under it. It was also intended to enlarge the scows used for hauling the feldspar across the lake to Glendower siding, so that the output for 1911 could be increased.

The company shipped some feldspar from the Card mine 2 miles west of Verona, but no mining was done here during the latter part of the year.

Mr. M. J. Flynn is superintendent, employing about 40 men.

McDonald Mine

The McDonald Feldspar Mining Company shipped steadily during the year from their properties on lots 4 and 5 in the tenth concession of Portland. Both feldspar and quartz were shipped. The feldspar is obtained chiefly from lot 4 where it is mined by open cut work, the open cut being 350 feet long and 50 feet deep. On lot 5 several smaller pits have been worked.

Mr. D. A. Brebner is managing director, and Mr. T. A. Gamey superintendent.

Talc

At the Henderson talc mine near Madoc operations were carried on continuously throughout the year under the direction of Mr. S. Wellington, who operates the mine under lease.

The main shaft has been sunk a depth of 175 feet, and on the 75-foot level a drift runs west 75 feet.

During the summer talc was mined by open-cut work east of the old open cut. The greater part of the talc mined is hauled by wagon to the talc mine at the railway station at Madoc, where it is ground for the trade. About 1,000 tons were shipped in the crude condition to the United States.

The talc mill operated by Geo. H. Gillespie and Company at Madoc station buys raw material from the above mine. Improvements were made at the mill during the year enabling the company to handle a larger tonnage. The ground talc is graded according to the requirements of the trade.

Electric power obtained from the Seymour Power and Electric Company is used for driving the machinery.

Fluorspar

Messrs. Gillespie and Wellington opened up a deposit of fluorspar during the year in the township of Huntingdon on the shore of Moira lake about 2 miles southwest of Madoc. The fluorspar was mined from an open cut 30 feet long and 25 feet deep.

Mica

The condition of the mica industry in eastern Ontario was about the same in 1910 as in 1909. With the exception of a couple of mines, the production comes chiefly from prospects that are intermittently worked. In no place in Ontario has the economic working of the deposits of mica been carried to a greater depth than about 200 feet; in fact, most of the mineral is excavated from above the 100-foot level. As a result, expensive plants are unnecessary. A horse whim and derrick constitute in a number of cases the surface plant. This equipment can easily be moved from pit to pit as the pockets are mined out. On some properties a large number of these shallow workings are found, nearly all of which have been producers.

Lacey

This mine, worked by the Loughborough Mining Company, has been the largest producer of amber mica in Ontario, and as yet is unsurpassed.

During the summer the mining work was confined wholly to the open pit, which is now 75 feet in depth. During the winter mining is carried on underground, chiefly in the parallel body south of the main workings. Here the drift has been run on the deposit for 200 feet in length and a stope carried 35 feet in height. The upper part of the main shaft has been re-timbered.

Mr. G. W. McNaughton is manager.

Other Mica Properties

On lot 1 in the eleventh concession of Loughborough, Mr. H. Richardson has been mining mica during the year. Three pits have been sunk to a depth of 45, 60 and 35 feet. On the deepest shaft, drifts have been run on the vein about 20 feet on each side of the shaft.

Mr. Richardson also did some prospecting for mica at the Baby mine, township of Burgess.

On the north part of lot 6 in the eighth concession of Loughborough, Messrs. Scriven and Whyte worked for part of the year. A shaft was sunk 50 feet, and some drifting done. On the lot adjoining the east of the above lot a pit was also sunk prospecting for mica.

Messrs. Stoness and Kent worked their mica property at Bob's lake for the greater part of the year. Several pits have been sunk on this property to a depth of 25 to 50 feet.

The Silver Queen property, on lot 13 in the fifth concession of Burgess, was opened in November by Mr. Edward Smith. He had been compelled to close operations the first part of the year owing to legal difficulties concerning the title. These were cleared away, and work is now proceeding at the property. The main workings remain unchanged. Another pit about 30 feet deep was, however, opened and some stoping done.

Mr. Rinaldo McConnell, Kent Bros., of Kingston, and Mr. J. A. Stewart, of Perth, were prospecting lots on the northwest side of Otty lake during part of the year

Mica Trimming Works

The following firms are engaged in trimming and thin-splitting mica in Ottawa:—General Electric Company; Laurentide Mica Company; Eugene Munsell & Company; Wallingford Mining and Mica Company; Mr. R. Blackburn; Mr. S. O. Filion; Mr. N. Holland; and in Kingston, Kent Bros. and Messrs. Richardson.

Graphite

The production of graphite is on the increase in Ontario. Three properties are now engaged in mining and refining graphite.

Black Donald Mine

At this mine, operated by the Black Donald Graphite Company near Whitefish lake, mining work is carried on during the summer months, producing sufficient crude material to keep the mill in operation the entire year. The condition of the underground workings is about the same as described in the last Report, with the exception that the stope has been extended further under the lake at the north end.

The system of concentration at the mill remains unchanged. Owing to the difficulties which attend the refining of graphite, the process is held as a trade secret.

Electric power is used both at the mine and the mill.

Mr. R. F. Bunting is manager, and Mr. Geo. W. Stewart superintendent.

McConnell Mine

Both the mine and mill of the Globe Refining Company near Port Elmsley were in operation the greater part of the year. At the mine, situated three miles from the mill, the shaft remains the same depth, but the stopes have been carried east and west from the shaft. In the stope east of the shaft, stulls have been put in and heavily lagged to support the roof.

Further changes have been made in the refining of the graphite at the mill.

Mr. C. Meech is superintendent of both mine and mill, employing 10 men at the mine and 12 at the mill.

Wilberforce Prospect

At Wilberforce, about 20 miles west of Bancroft on the Irondale, Bancroft and Ottawa railway, a large mill for the concentrating and refining of graphite is in course of erection. Very little mining work has yet been done at the mine, which is situated a short distance from Wilberforce. Mr. W. M. Matthews, of Toronto, is in charge of the operation.

Corundum

The Manufacturers Corundum Company are now operating under lease the mines and mills of the Canada Corundum Company and the Ashland Emery and Corundum Company. They are also working the Armstrong property. All the corundum is mined by open-cut methods, on account of the limited depth to which it has so far been found to occur. Corundum has been taken from the hill at the Craig mine over a surface area of 25 to 40 acres. This hill is still furnishing most of the ore for the mill. Some ore is also being obtained from the workings known as the Klondike on the west end of the hill.

The mill at the Craig and the Ashland have been fully described in former reports of the Bureau.

Mr. D. A. Brebner is managing director, and about 200 men are employed by the company.

Silver Refineries

Deloro

The Deloro Mining and Reduction Company have works at Deloro, 2 miles east of Marmora station, Central Ontario railway, for refining the silver-cobalt ores from the Cobalt area. At these works silver and arsenic are produced in their refined state, and cobalt and nickel in the form of oxides.

Electric power is used entirely at the works, and is obtained from the Seymour Power and Electric Company.

Mr. S. B. Wright is manager.

Swansea

At Swansea, Ontario, the Swansea Smelting and Refining Company have begun the refining of silver-cobalt ores. The plant was put in operation in 1910, and is situated about one-half mile north of Swansea station, Grand Trunk railway.

Mr. F. B. Allan is president, and Mr. B. E. Hoffman manager.

Marble

The Ontario Marble Quarries, Limited, are quarrying marble on lots 28 and 29 in the tenth concession of Dungannon, and on lot 41, West Hastings road, being about two miles south of Bancroft and one-half mile from the Central Ontario railway.

No. 1. quarry on lots 28 and 29 has an excavation 60 feet long, 60 feet wide and 20 feet deep. A 20-ton steel derrick has been erected and a channeler put in use for quarrying the marble. The blocks taken out are about 6 feet by 5 feet by 5 feet. These blocks are picked up by means of the derrick and placed on tram cars, and then taken directly, without further handling, into the mill for sawing.

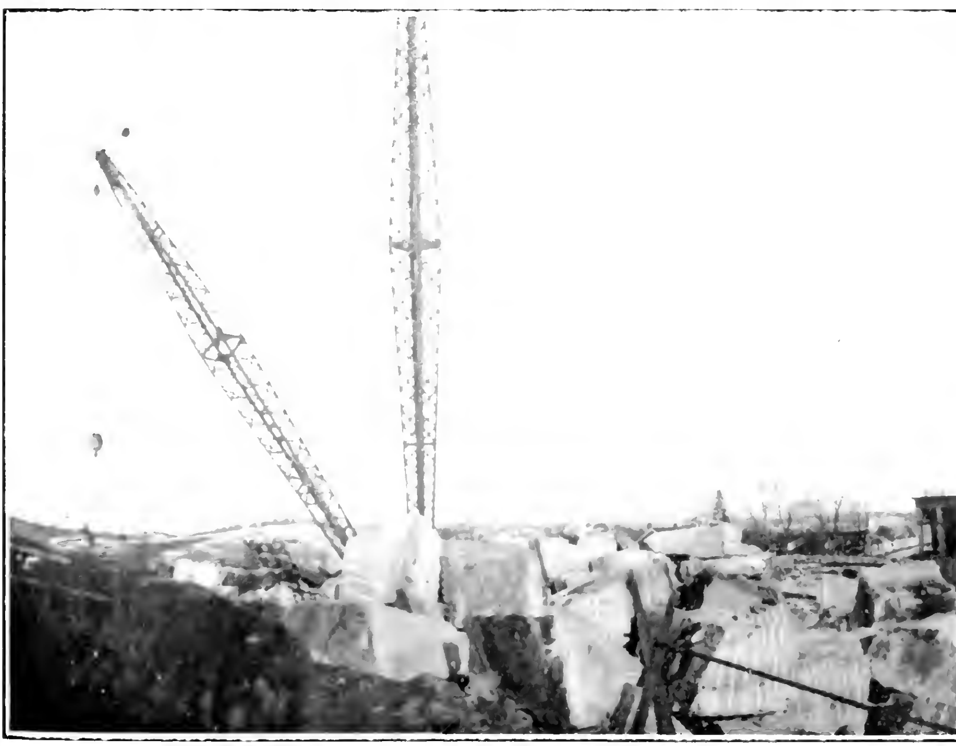
No. 2 quarry is situated on lot 41, about one-half mile west of No. 1. An area 100 feet wide by 75 feet long has been stripped, and three machine drills are at work blocking out the marble in blocks 5 feet by 5 feet by 6 feet. A large derrick has been erected here for handling the blocks of marble.

Adjoining No. 1 quarry is located the works in which the marble is sawed into slabs. This plant consists of one 90-h.p. boiler, one engine and two gang saws. Each of these gang saws contains 37 blades placed so as to saw slabs about 1 inch in thickness. The marble in this form is shipped to Toronto, where it is polished and cut to sizes according to the requirements of the trade.

The marble grades from a white to grey in the No. 1 quarry. At No. 2 quarry it is found in a variety of colours, consisting of pink, greenish, mottled and brecciated.

Mr. T. Morrison is superintendent, employing 65 men.

Ontario Marble Quarry No. 1.



Ontario Marble Quarry No. 2.

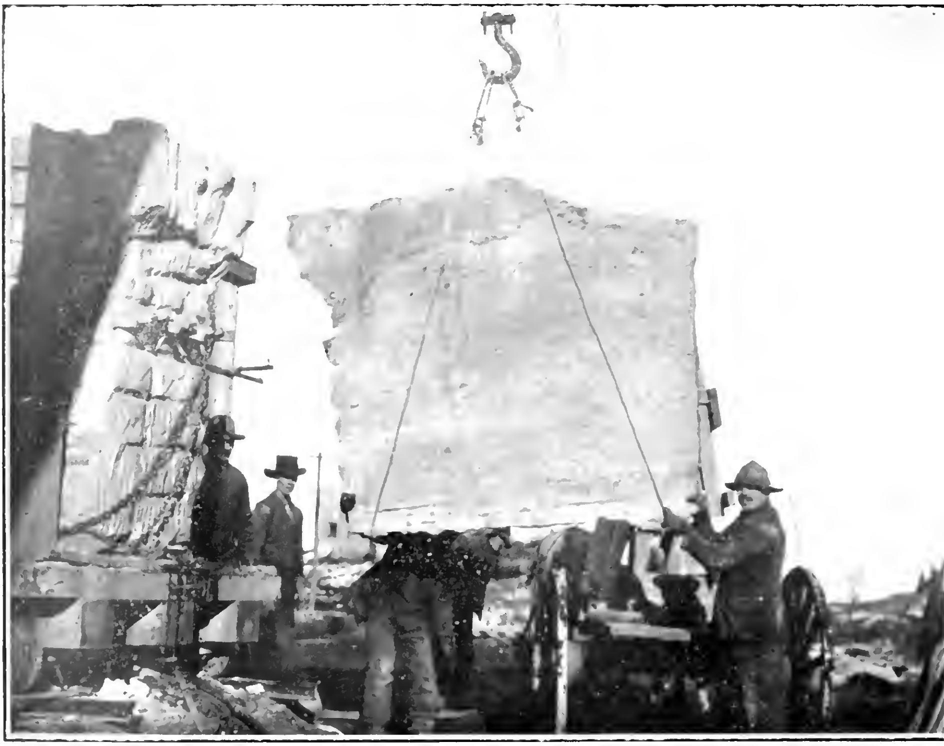
Lanark Quarry

Near the town of Lanark a marble quarry has been worked for some time. The marble is shipped during the winter by team to Lavant station, Kingston and Pembroke railway.

Limestone Quarries

Lehigh

At the Lehigh plant of the Canada Cement Company, at Point Anne, 6 miles from Belleville, limestone is being quarried for use in the manufacture of cement. This



Ontario Marble Quarries, near Bancroft, showing block of marble.

limestone is of Trenton formation, and, being low in magnesia, makes an excellent rock for the manufacture of cement. It is also a good building stone. A sample[2] of this rock shows the following composition: silica 1.64, ferric oxide .53, alumina .21, lime, 54.06, magnesia .55, carbon dioxide 42.90, sulphur trioxide 0.1.

The quarry is now about 30 feet deep, 500 feet long and 350 feet wide. After the rock is broken it is loaded into 5-ton cars by means of a steam shovel. This rock is then hoisted into the mill, where it is crushed in large gyratory crushers, passing through a series of these until it is reduced to the proper fineness. An electric hoist is used to hoist the rock into the mill.

Mr. T. McGinnis is superintendent of the quarry and mill.

[2]B.M., Vol. 13, Part ii., page 61

Point Anne

At Point Anne, about one-half mile from the Lehigh Cement plant, the Point Anne Quarries, Limited, are quarrying limestone and crushing it for use in concrete work. The quarry is very shallow as yet, there being a bank about 12 feet in height from which the rock is blasted. It is then loaded on cars by a steam shovel and taken to the crushing plant located at the dock, where it is crushed and graded. It is then taken by belt conveyor to storage bins, from which it is loaded into boats. The quarry is only operated during the season of navigation. The machinery is now driven by electric power obtained from the Seymour Power and Electric Company.

Mr. W. M. Greig is superintendent.

Gloucester

H. Robillard and Sons are operating a limestone quarry in Gloucester township, about three miles from Cummings Bridge on the Montreal road. These quarries are in Trenton limestone, very high in lime and low in magnesia. About 25 men are employed at the quarry during the summer.

Burnt River

Britnell and Company, of Toronto, are operating a quarry about three-quarters of a mile south of Burnt River station, in the township of Somerville. This limestone is of Black River age and occurs in a ledge 40 to 50 feet in height. The large blocks are used for building stone, and the refuse crushed and shipped to Toronto for use in concrete work. About 30 men are employed.

V.—SOUTHWESTERN ONTARIO

This area, comprising all that part of Ontario south of a line drawn from Toronto to Key Harbor on Georgian Bay, has been known chiefly as productive of oil, gas and salt. Other important mineral industries are now coming into prominence. Some of them derive their raw material from other parts of the Province, such as the Coniagas Reduction Company at Thorold, and the blast furnaces at Hamilton and Midland.

The mining of gypsum in the valley of the Grand river has for many years been of importance. It is now occupying greater attention due to the construction of larger plants for crushing, calcining and manufacturing alabastine, wall plaster, etc.

The quarries in this part of Ontario are also of great importance. Stone is quarried for building purposes, cement manufacture, making of lime, and, when crushed, for concrete work.

Canada Refining and Smelting Company

The works of the Canada Refining and Smelting Company are located at Orillia and commenced the treatment of cobalt-silver ores in April, 1911, with a capacity of about 10 tons of ore per 24 hours. The company produce refined silver, and, with the completion of their larger plant, will also make refined white arsenic (As_2O_3), and cobalt and nickel oxides or hydrates. The company secure power for driving their machinery from the town of Orillia, which contracts to sell electric power to manufacturers at $16.00 per h.p. per year. Nothing but high grade ore has as yet been bought by the company. Mr. W. F. Aimy, Orillia, is manager.

Coniagas Reduction Company

The works of the Coniagas Reduction Company, the capital stock of which is owned by the Coniagas Mines, Limited, are located at Thorold. This company buys silver-cobalt ore not only from the Coniagas mine, but also from other mines in the camp.

The capacity of the works has been enlarged and the plant for making cobalt and nickel oxide completed. Refined silver and arsenic are produced; also the oxides of cobalt and nickel.

Mr. R. L. Peek is superintendent.

Blast Furnaces

Hamilton

The Hamilton Steel and Iron Company was taken over by the Steel Company of Canada, Limited, which is an amalgamation of the above company with the following: Canada Bolt and Nut Company, Canada Screw Company, Dominion Wire Manufacturing Company and the Montreal Rolling Mills Company. The head office is in Hamilton, Mr. R. Hobson being president and Mr. H. H. Champ, treasurer.

The company have two furnaces in blast, producing about 500 tons of pig iron per 24 hours. The greater part of the raw ore is obtained from mines in Minnesota. One of the furnaces is of modern type of construction and the other is of the old type of hand-filled furnaces. The company also have an open hearth plant a short distance from the blast furnace.

Midland

The Canada Iron Corporation completed the construction of their new furnace at Midland in August, 1910, and it has since been in operation. The old furnace was in blast up to that time. It is the purpose of the company to rebuild the old furnace. The new furnace is of Roberts design, and has a capacity of 300 tons of pig iron per day. Additions are also to be made to the blowers to make them adequate for the new furnace.

Mr. A. C. Adams is superintendent, employing 150 men.

Gypsum

The production of gypsum in Ontario, according to the Report of the Royal Commission to investigate the Mineral Resources of Ontario, 1890, began about 1864, and since that time there has been a steady production. The gypsum beds are found in the Onondaga formation in the valley of the Grand river in the counties of Brant and Haldimand. Two qualities of gypsum are mined, the white and the gray. The white gypsum is quite pure, and is used in the manufacture of alabastine, stucco and for ornamental work. The gray variety, which has the largest production, is used in cement making to regulate the setting, and as a fertilizer. The beds of white gypsum are found generally with a thickness of three to four feet. Overlying the beds are layers of dolomite shales and limestone, in all from 4 to 6 feet in thickness. These are covered by 40 to 50 feet of post-glacial drift. The beds of gray gypsum have a thickness of 6 to 9 feet, and overlying these are 25 to 40 feet of layers of dolomitic limestone and shales. These also have a covering of post-glacial drift from 40 to 50 feet thick.

It is necessary to call attention to the kind of incline shafts that have been sunk in this area. These shafts are as a rule only constructed wide enough to permit of the passage of a car. Little attention has been paid to the requirements of the Mining Act, which provide for a separate travelling way for the workmen in all shafts. When power hoists are used, the danger from workmen being caught by the cars is made much greater. There is also the danger of cars breaking away and running uncontrolled down the shaft. In future, workmen must not be allowed to travel in these incline shafts while hoisting is in progress; and any new shafts constructed must be in accordance with the requirements of the Mining Act.

The Alabastine Company

This company are working a gypsum mine situated three-eighths of a mile north of the town of Caledonia. An incline shaft about 800 feet in length has been sunk to the beds of gypsum. This has a vertical depth of about 80 feet. Before machinery was installed, a horse was used to haul the cars of gypsum up the incline shaft. The bed of gypsum being worked is 7 to 8 feet in thickness and lies horizontally. It is mined by the room-and-pillar method. At present the underground workings on the lower seam extend over one acre in area.

An electric driven drill is used for boring holes for breaking down the gypsum, a 10-foot hole being bored in 5 to 10 minutes.

A mill for crushing, grinding and calcining the gypsum has been erected near the mouth of the incline shaft. The incline skipway leads directly into the mill, where the cars dump into bins from which the gypsum is fed into crushers and then, by continuous process, passed through finer crushers to the calciners, then through pulverizers to the storage rooms for shipment. A spur from the Grand Trunk railway has been built to the mill.

Natural gas is used in gas engines for generating power to drive the mill, and for generating electricity for use underground.

Instructions were given with regard to sinking a new shaft, handling of explosives, etc.

Mr. H. J. Haire is superintendent, employing about 40 men in the mine and mill.

Carson Mine

The Alabastine Company are also operating a property about 3 miles south of Caledonia for white gypsum. The incline shaft is about 500 feet in length. The workings extend over an area of about 300 feet long by 200 feet wide. The waste rock is used for filling for pillars. An air shaft 75 feet in depth has been sunk to the workings. The bed here is about four feet in thickness. A horse is used for hauling the loaded cars up the incline shaft.

Caledonia Gypsum Company

This company are operating a gypsum mine one-half mile west of Caledonia. An incline shaft 260 feet in length has been put down to the bed of gypsum, connecting with a vertical shaft 72 feet in depth. Stoping on the deposit has just started. Another vertical shaft has been sunk 70 feet, 200 feet south of the vertical shaft. A mill has also been erected for crushing the gypsum.

The plant consists of two gas engines, a crusher, an electric generator and an electric hoist.

A spur has been built from the Grand Trunk Railway to the mill.

Mr. E. J. Hunter, of Hamilton, is managing director.

Crown Gypsum Company

One-half mile from York on the south side of the Grand river in Oneida township, the Crown Gypsum Company are operating a property which has been described in former Reports of the Bureau of Mines as the Martindale mine. The report of the Inspector of Mines for 1896 states that an area from 25 to 30 acres had been mined out.

A new incline shaft 500 feet in length has been sunk from the west side of the deposit and connected with the old workings. The gypsum bed is about four feet in thickness. It is mined by the room-and-pillar method, the waste rock being left underground and built up as pillars to support the roof. At various places in the gypsum bed are found large cavities from which the gypsum has been dissolved out. The rock covering the gypsum bed is only from 4 to 6 feet in thickness, and on the edge of the deposit where the gypsum ends, the rock covering has been eroded, and the workings run into post-glacial drift. The bed of gypsum terminates on all sides in this manner.

The power plant consists of a 90-h.p. boiler, compressor and engine for operating the hoist. A narrow gauge railway has been built from the mine to Lythmore station, Michigan Central railway, where the mill for grinding the gypsum is located.

Instructions were given regarding the use of explosives and working on the incline shaft.

Mr. J. A. Nelles is superintendent.

Limestone Quarries

Brown Quarry

The Messrs. Walker Bros., of Merritton, are working a quarry in the township of Stamford, 2 miles east of Thorold.

The rock quarried is limestone, which is used for curbstones, bridge works, window sills, etc.

The firm has a mill at Merritton where the stone is sawed for the various uses.

Hagersville Quarry

The Hagersville Contracting Company are operating a quarry on lot 14 in the thirteenth concession of Walpole township, county of Haldimand. The product is used as a flux by the St. Thomas Car-Wheel Works, as road material, and for concrete work.

Mr. D. C. Ingals is manager, employing about 60 men during the summer months.

Canada Iron Corporation

On the north half of lot 19 in the fifth concession of Tay township, county of Simcoe, the Canada Iron Corporation are quarrying limestone for use as a flux at their blast furnaces. The quarry is situated on the shore of the bay and the stone is hauled by boat to their ore dock at the blast furnace.

Anderdon Quarries

In the township of Anderdon, county of Essex, the Amherstburg Quarry Company are operating a quarry of limestone. This limestone is of Corniferous age and carries beds high in magnesium. The quarry has been worked for some years and is of considerable extent. The company employ 60 to 70 men.

Sherkston Quarries

The quarries of the Empire Limestone Company, at Sherkston, county of Welland, have the largest production of any quarry in the Province. This company employ 200 men.

The limestone is of Corniferous age, and differs from rock of the same age in Essex county in being low in magnesium. It is unusually pure, and is therefore an ideal rock for the manufacture of calcium carbide, in which it is extensively used. It is also shipped to the iron and steel plants at Buffalo and Hamilton, where it is used as a flux.

Natural gas being found in quantities near, it is utilized as a fuel for making lime out of this rock.

There are a large number of other quarries in this part of Ontario where the limestone is quarried and used for building purposes, road material, concrete work, making lime, etc., that were not inspected during the year.

SILVER IN THUNDER BAY DISTRICT

BY N. L. BOWEN

During the summer of 1910 the writer, assisted by Mr. A. F. Mahaffy, was occupied in the examination of the silver-bearing area in the Thunder Bay District of Ontario. The more detailed work was confined to the townships of Strange, Lybster, Gillies, and Scoble, but trips were made to other interesting parts of the area to see prospects and clear up relationships.

The Thunder Bay District extends from Lake Superior to the northern boundaries of the Province, and takes its name from the embayment on the north shore of the lake which contains the two harbors, Port Arthur and Fort William, the head of lake navigation.

Silver has been mined on the shores of Thunder Bay and in the area tributary thereto for some years. The history of the region is long and varied. As early as 1846 a small quantity of copper-silver ore was mined at Spar Island, about 24 miles south of Port Arthur. Little work was done, however, and it was not until the discovery of the Thunder Bay vein (1866), Shuniah vein (1867), and Silver Islet vein (1868), that extensive mining was begun. Within a few years the famous Silver Islet vein had produced about three and a quarter millions of dollars. The production of the other properties was small, and toward 1880 the total output of the district had fallen off to an insignificant amount.

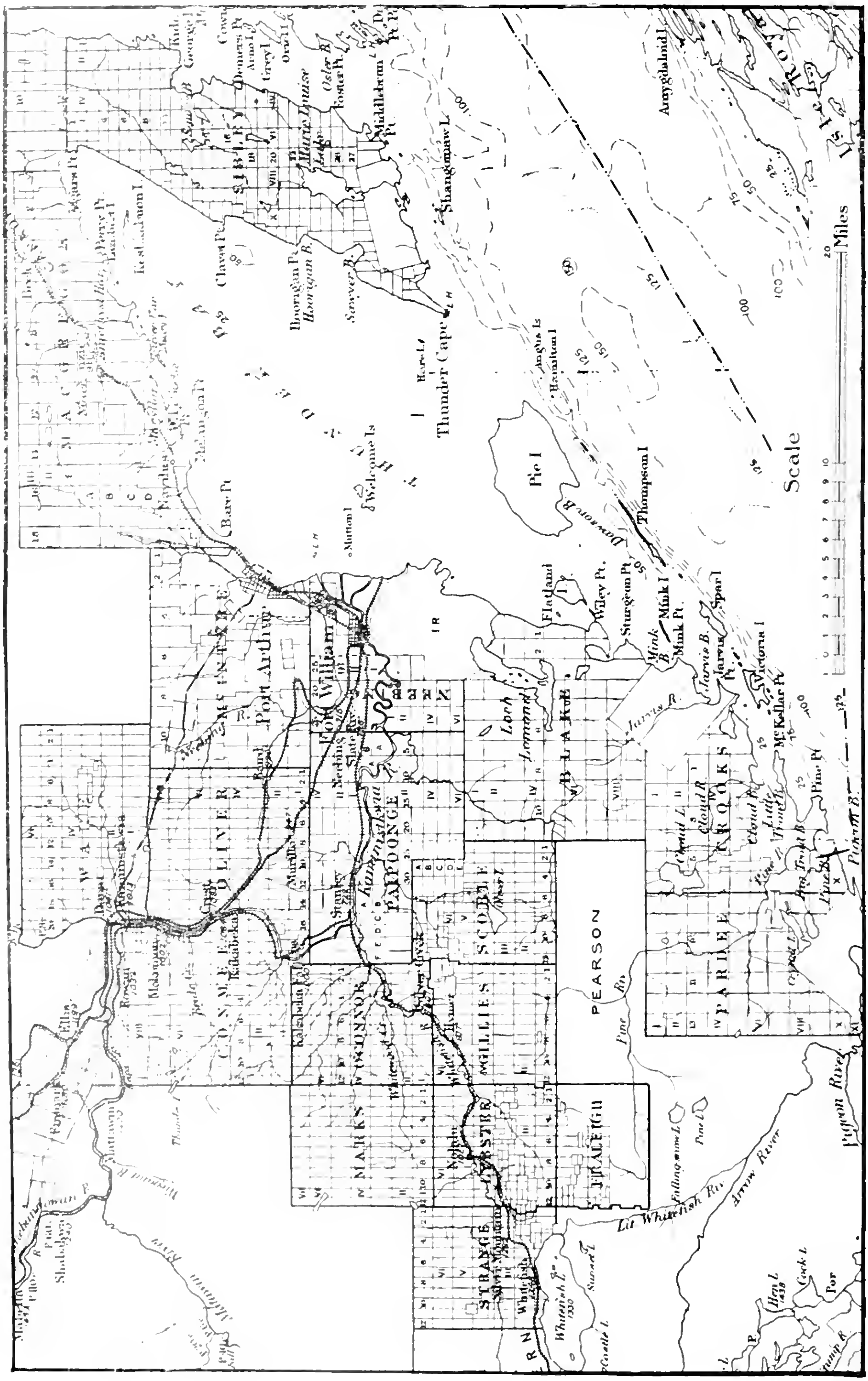
It was the discovery of the Rabbit Mountain vein in 1882 which led to further prospecting, with the result that numerous rich veins were found along the southern edge of the Whitefish valley, southwest from Port Arthur. Mining flourished until 1892, when the price of silver fell and work was discontinued at all the properties. Again in 1898 the West End mine was re-opened and operated continuously until 1903. The little work that has been done in the district since 1903 has been of the nature of prospecting and testing.

Looking southeast from Rabbit mountain.

Topography and Drainage

The area is one of bold relief. The differential elevation is not great, but the hills usually rise from the valleys with steep or even cliff-like faces, the result of erosion, in nearly horizontal, hard and soft beds. A stream, having once cut through a diabase

[1] A somewhat detailed description of the economic resources of this district was published by Mr. E. D. Ingall in the Report of the Geological Survey of Canada, for 1887. The present report is intended to supplement that of Mr. Ingall.



Key Plan showing location of Silver Mountain Area, near Fort William, on the North Shore of L. Superior.

Massive diabase resting on gray quartzite.

Table hill illustrating structure.

sill, lowers its bed very rapidly in the softer sediments, leaving diabase-capped hills either as isolated "table tops" or as ridges with steep northward faces and gentle southern slopes, approximately parallel to the dip of the "hard bed," in this case a diabase sill. Only on the steep sides of the hills are good rock exposures to be obtained; the valleys are filled to a considerable depth with glacial detritus.

The drainage is characterized by a well-defined stream system. Swamps and lakes are few. The contrast with the ill-defined drainage of much of the pre-Cambrian area of Canada is marked. It can hardly be doubted that the present disposition of hill and valley was established in pre-glacial time and was but little modified by glacial erosion. Post-glacial time has been sufficient merely for the cutting of stream beds in the drift which the retreating glacier left.

The valleys support a growing number of prosperous settlers.

Terrace of the Whitefish at Hymers.

Geology

The rocks of the area, other than the glacial deposits, are all of pre-Cambrian age. To the north is a great area of granitoid gneiss known as the Laurentian. To the south the gneiss is overlain by the sediments of the Animikie or Upper Huronian.

In the Animikie are intrusive sills of diabase, presumably Keweenawan.

Tabular View of Formations

Glacial and Recent.—Boulder clay, stratified sands and clays. Great uncomformity.

Keweenawan.—Intrusive sills and dikes of diabase (Logan sills). Intrusive relationship.

Upper Huronian or Animikie.—Gray argillites. Gray quartzite with gray slate interstratified. Black slate. Iron formation (jasper, chert, pyritic slate, greenalite rock, etc.). Great unconformity.

Laurentian.—Granitoid complex.

The Laurentian

The Laurentian is made up of somewhat gneissic rocks, usually granitic, but sometimes syenitic or even dioritic. A specimen taken from an outcrop on the Kaministiquia, about a mile above the Kakabeka falls, showed, in thin section, quartz, orthoclase, plagioclase, and muscovite. There are no features of special interest in this connection, and little time was put on the gneiss area.

The Animikie or Upper Huronian

The Animikie is one of the great pre-Cambrian sedimentary series. The term Animikie was first used in this area, and the Upper Huronian age was determined by the correlation work of the International Committee of Canadian and United States geologists in 1904.

The Animikie beds have in this area a gentle average dip to the southeast, the lowermost beds outcropping towards the north and the higher farther south. The relation between the Animikie and the gneiss is to be seen in many parts of the area. The main contact between the two systems is usually a fault contact. A good exposure is to be seen on the western boundary of Strange township in the bed of the Whitefish river. Gneiss forms the northern bank of the stream and the Animikie sediments the southern. Approaching the gneiss the beds rapidly assume a steeper and steeper dip, and near the contact are almost vertical. The sediment is a greenish slate, and does not represent the base of the Animikie. Within the gneiss area small outlying patches of jasper are found which represent the base.

The complete section is shown near the Kakabeka falls on the Kaministiquia river. Here the increased dip of the sediment is not so marked, and the gneiss can be seen dipping under the cherty beds at the base of the Animikie. There is no detrital material at the base, and this fact, together with the disturbed condition of the beds, might be taken as evidence of an intrusive nature for the granite. However, no contact effects are to be seen, and no stringers run out from the mass of granite. On the whole, therefore, the conclusion is that the sediment is younger than the gneiss, which, indeed, formed the floor on which it was laid, and that the disturbance of the beds is due to later movements. It is rather remarkable that only along this contact is any serious disturbance of the Animikie beds to be noted. It will be seen that only the pre-Animikie age of the granite is established. There are post-Lower Huronian granites near by, but it is highly probable that this vast area belongs to the pre-Huronian complex (Laurentian).

A reference to the tabular view shows that the Animikie has at the base the sediments of the iron formation overlain by black slate, this by gray quartzite, and finally by gray argillites.

It is the Animikie iron formation in which are found the deposits of the Mesabi range, the greatest of North American iron ranges. In the area under discussion the iron formation outcrops along the north fringe of the series, and consists of jaspers, cherts, pyritic slates, and greenalite rocks. No detailed description of these sediments will be given. Slides of typical specimens were examined and compared with photomicrographs in Leith's monograph on the Mesabi. Nothing of special interest in this connection was noted.

The black slate division outcrops in a belt immediately south of the iron formation. It is important as being a silver-bearing horizon.

On surfaces exposed to the weather the slates are decidedly fissile, cleaving into thin plates; but in fresh workings the rock is rather massively bedded. This effect of the weather makes the slate crumble easily, so that it never outcrops of itself, but only where held up, as it were, by an overlying sill of diabase.

The outcrops of the black slates are, then, to be found only on the steeper hillsides, and are on the whole rare. In the Rabbit Mountain area, frequent outcrops are found on the sides of the diabase-capped hills, and so also in the Silver Mountain area; but in the intervening belt no diabase was intruded immediately above the black slates, or if it was, it has been cut away and the belt is low and drift-covered. The hillsides to the south show only the next higher division of the Animikie, the gray quartzite, so that there are here no black slate outcrops. Since the silver discoveries of this belt were always made in the black slate hillsides beneath the diabase, we have in the erosional development an explanation of the grouping of the finds into the Rabbit Mountain group and Silver Mountain group.

The term slate is used rather loosely, for the only cleavage is parallel to the bedding. The rock is fine-grained, rather soft, and owes its black color to the presence of

[illegible] the Beaver, Porcupine, Rabbit [illegible] and others are in the black slates.

The gray quartzite [illegible] overlies and outcrops in a belt to the south of the [illegible] the quartzite are interbedded frequent layers of a gray sla[illegible] in the lower part the gray slate predominates and is probably the same rock as t[illegible] [illegible] matter. The quartzite itself is hard, greenish-gra[illegible], fine-grained and feldspathic. The beds average about one foot thick. Although mu[illegible] more resistant than the black slate it too outcrops only on hillsides beneath diabas[illegible]

This is the [illegible] of the Animikie that occurs in the area where detail[illegible] work was done. To the south comes in the belt of gray argillites, dark gray, hea[illegible] bedded and somewhat metamorphosed shales usually carbonaceous.

Kakabeka falls and gorge in Animikie strata

The Animikie [illegible] as a whole, except as pointed out above, near their contact with the Laurentian [illegible] a gentle dip, usually about 5 degrees, but sometimes more or less. The direction [illegible] ranges from southeast to southwest, the average, as shown by the general strike being S. S. E. Rarely the dip may be northerly, as was observed on the shores of [illegible]

The thickness of the Animikie has been estimated from its horizontal extension and average dip to be over 12,[illegible] feet. This estimate includes the sills, which amount

to nearly one half and do not properly belong. Moreover, faults are numerous in the Animikie. They are never extensive enough to be conspicuous, but in the zone of vein workings they are frequent, and there is no reason to believe they are any less numerous outside of this zone. They are all normal faults, and the effect has been to greatly increase the apparent thickness. It is probable, therefore, that the total thickness is closer to 5,000 feet, apportioned approximately as follows:

Quartzite and argillite	3,500 feet.
Black slate	500 feet.
Iron formation	1,000 feet.

Patches of slate on top of diabase sill, Current River park, Port Arthur.

Diabase (Keweenawan)

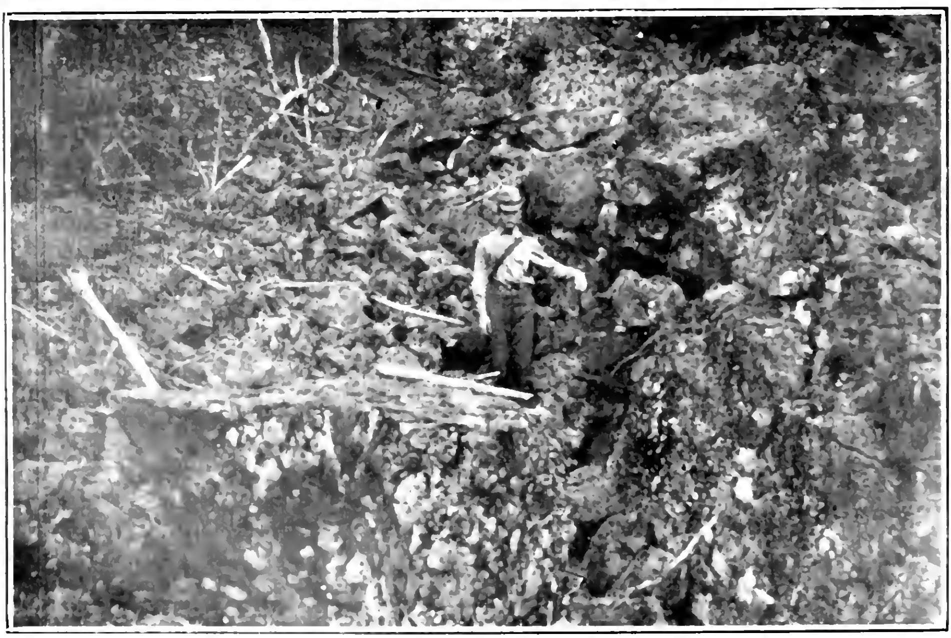
Intrusive sills of diabase are numerous in the Animikie strata. All the hills are capped by this resistant rock. This fact led to the erroneous idea that the diabase was a single flow poured out on the surface and led to the name of "crowning overflow." Lawson exploded this idea in his paper on the "Laccolithic Sills of the North West Coast of Lake Superior," where he maintained that the diabase represented a number of intrusive sills at different horizons.

There is abundant evidence of the truth of this statement.[2] It has been pointed out that the southern slopes of the hills commonly correspond with the dip of a sill; indeed, the top of the hill in many cases is the absolute top of the sill. With careful search, small thin patches of sediment, baked by the contact action, can be found on top of the intrusive. Another interesting feature to be seen where the tops of the sills have been thus laid bare are the contraction dikelets which cut the diabase in a confused network, evidently filling cracks formed in the suddenly chilled outer portion of the sill.

The steep northward slopes of the diabase show a vertical columnar jointing which gives rise to the cliff faces. Great quantities of talus accumulate at the base of the cliffs. The rate at which the cliffs recede must be quite fast, for, according to the observations of settlers, large masses are hurled down every winter.

[2] Ingall "Mines and Mining on Lake Superior," Geol Surv., Can., 1887.

Top of a diabase sill, showing contraction dikelets, lot 10, con. I., township of Gillies.



A diabase talus slope.

The sills range in thickness from a few feet to five or six hundred feet. The evidence for their laccolithic nature is scanty because of the removal of overlying sediments, but in a few places small patches are left in such an attitude as to indicate an arching of the strata. An example is shown on R10, Scoble.

The diabase is a fine-grained, dark rock composed of labradorite and augite in ophitic structure, with some biotite, apatite, iron ores, and generally a little quartz. In one specimen from a small sill, quartz was absent and considerable olivine present. A few feet from an upper or lower contact the diabase commonly becomes porphyritic, showing phenocrysts of feldspar. The phenocrysts have in many cases collected into bubble-like masses, 2 to 10 feet in diameter, anorthosites in composition but lacking sufficient size to be considered geologic units. It is possible that by an extension of this process bodies of anorthosite might be produced.

The contact effect of the diabase on the iron formation, black slates, and the quartzite of the Animikie is confined to a slight baking and bleaching. With the argillites, however, interesting contact effects are to be noted. The numerous good sections along the shores of Lake Superior show the development of reddish adinoles at the contacts, and in some cases the action has been so intense as to completely recrystallize the adinole, giving it the texture of a granophyre. Ingall noted this at many places. The writer examined only the Spar Island example.

Glacial and Recent

Much of the surface is covered by glacial till, chiefly unassorted boulder clay. In the valleys these materials have been worked over by streams, giving some stratified sands and clays into which the streams are now cutting their valleys.

The direction of glacial striæ observed at a few points is S. 38 to 44 degrees W.

Economic Geology

The veins of the black slate belt occur in fault fissures with a general northeast strike and dip 60 to 90 degrees. The outcroppings were usually discovered in slates near the base of a diabase sill or else in the sill itself, and thence followed downward to the slates, where the best values are found.

Silver is present as argentite and native silver, associated with zinc blende, galena and pyrite. The gangue is calcite, quartz and fluorite, with sometimes barite and witherite.

The most important find outside the belt of black slates was that at Silver Islet, and with this may be grouped a number of minor finds on the shores and islands of Lake Superior. These are all in the belt of gray argillites; a north and south strike is common, and they are all near diabase intrusions. At Silver Islet, for example, a diabase dike cuts the argillites and the vein cuts both. Only in the part of the vein enclosed between diabase walls were values obtained.

The mineral assemblage of this group of veins is in general the same as that of the black slate group. At Silver Islet some arsenical ores were found.

The association of the veins with diabase intrusions suggests the origin of the ore minerals in waters accompanying the diabase. Although it might at first sight seem so, this conclusion is not contradicted by the fact that the diabase itself suffered faulting and fissuring before the time of vein filling, for it is well known that, in volcanic districts, warm mineral-laden waters circulate in fissures (forming hot springs when they reach the surface) at a time long after that at which volcanic activity itself has ceased.

The general relation is somewhat similar to that in the Cobalt district; indeed, it is probable that mineralization in the two districts was approximately of the same period.

Dr. W. G. Miller, in his report on the Cobalt area, has compared the two camps at some length.[3] It may be of interest to give here a table showing the contents of the veins in metallic minerals.

[3]Cobalt-Nickel Arsenides and Silver Deposits of Temiskaming, Ont. Bur. Mines, Vol. XVI., 1907, pt. II.

Port Arthur.	Native Elements.	Cobalt.
—	Silver (Ag).	**—**
—	Bismuth (Bi).	**—**
—	Graphite (C)	—
—	Arsenic (As).	
	ARSENIDES.	
—	Niccolite (NiAs).	**—**
—	Domeykite (Cu_3As).	
—	Macfarlanite. ?	
—	Huntilite ?	
	Chloanthite ($NiAs_2$).	**—**
	Smaltite ($CoAs_2$).	**—**
	ARSENATES.	
—	Erythrite ($Co_3As_2O_8 . 8H_2O$).	**—**
—	Annabergite ($Ni_3As_2O_8 . 8H_2O$).	**—**
	SULPHIDES.	
—	Argentite (Ag_2S).	—
	Millerite (NiS).	—
—	Galena (PbS).	—
—	Sphalerite (ZnS).	—
—	Pyrite (FeS_2).	
—	Marcasite (FeS_2).	
—	Pyrrhotite ($Fe_{11}S_{12}$).	
—	Chalcopyrite ($CuFeS_2$).	
—	Chalcocite (Cu_2S).	
—	Bornite (Cu_3FeS_3).	
	SULPHARSENIDES.	
—	Mispickel (FeAsS).	—
	Cobaltite (CoAsS).	**—**
	Proustite (Ag_3AsS_3).	—
	ANTIMONIDES.	
—	Animikite. ?	
	Dyscrasite (Ag_6Sb).	**—**
	SULPHANTIMONIDES.	
—	Tetrahedrite (Cu_8SbS_7).	—
	Pyrargyrite (Ag_3SbS_3).	—
	CHLORIDE.	
—	Ceragyrite (AgCl).	

NOTE.—A line opposite the name of a mineral and beneath the name of the district denotes the presence of the mineral in that district. Lack of the line indicates that the mineral has not been noted in the district. The heavy lines show special prominence of the mineral indicated.

There is evidence favoring the idea that carbonaceous matter of the sediment may have been active as precipitant of the ore minerals. The rich silver finds of the black (carbonaceous) slate belt are effectively limited to the north by the iron formation and to the south by the quartzite; and the gray argillite with its group of finds is also decidedly carbonaceous.

An alternative explanation of the larger number of veins being found in the black slates is that the belt where the slates now occur at the surface was a zone of more marked faulting. This is probably not the case, for there are numerous veins occupying fault fissures in the other divisions of the series. The question could, of course, be decided by following veins downward from the black slates into the underlying iron formation. This has been done at least in one of the mines, but no definite data as to the nature of ore bodies encountered are obtainable.

Properties

It has been pointed out that only a little test work has been done in the district since 1903. The facilities for examining properties were therefore poor, and but little new information could be obtained on those which have been closed for some time.

Black Slate Belt Group

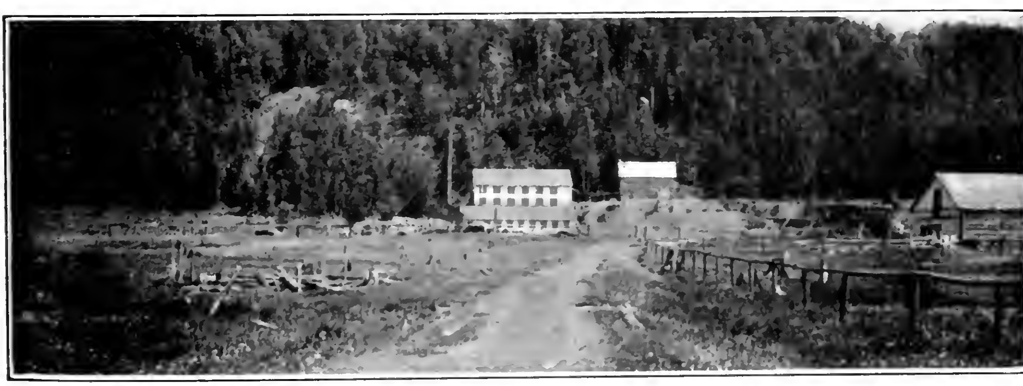
West End Silver Mountain mine, R. 56 Lybster.

The vein worked on this property is typical of all the veins of the group. It occurs in the black slate beneath a diabase sill. The ore minerals are argentite, native silver, galena, sphalerite and pyrite, and the gangue calcite, quartz and fluorite.

The old workings are among the most extensive in the district. A total of $365,681 produced from 1898 to 1903 came almost entirely from this property. Little work was being done at the time of the writer's visit. The mine was kept pumped out. Where a good pocket was shown on any of the faces, a shot was put in and the best taken. In this way a carload of ore was made up from time to time. No attempt was being made to mine large quantities and concentrate, as was formerly the practice there. It is difficult to state what hope of success there would be in such a course. The vein is still strong in most of the drifts, but the ore is lean. Whether undiscovered pay shoots would be encountered remains to be proven by vigorous development.

Beaver mine, 97 T., O'Connor.

The Beaver mine was closed down in 1891, after producing over half a million dollars. For sixteen years it lay idle. In the fall of 1907, pumping out was begun. The old mill having been burned, a new one was constructed, the purpose being to concentrate the low grade ore of the old dumps and new ore from the mine. With the first run, it is said, the mill was found to be of faulty construction, the whole was closed down, and has so remained since. It is unfortunate that the work was not persisted in, for this property, the richest of the group, would have furnished a good test case as to whether properties closed in the "crash," when silver prices suffered so severe a fall, could be worked under the existing conditions. The main vein has an average width of about four feet and, unlike the rest of the group, strikes in a northwest direction. It was characterized by its bonanza shoots.



New mill at the Beaver mine.

The Porcupine mine, 96 T., Gillies.

The Porcupine was one of the important producers in the days of active mining. In recent years it has been re-opened a number of times. Pockets rich in native silver and argentite were encountered, but owing to the discouragement caused by lean portions, the work has always been given up.

The workings show a strong vein, averaging about four feet in width, and well mineralized in places.

Climax, 145 T., O'Connor.

On the Climax property testing has been done on three veins with an approximately parallel (N.E.) strike, and each of an average width of about one foot. In 1891 a small quantity of rich ore was taken from one of these veins, but the workings have now caved in.

On another of these, a shaft was being sunk at the time of the writer's visit, and a depth of 60 feet had been attained. The vein dips 60 degrees north, lying in a fault fissure, the extent of faulting being about 30 feet. In the upper portions of the vein the down faulted diabase sill forms one wall with slate as the other, but in the lower portions slate forms both walls. The mineralization is moderate, with a fair sprinkling of argentite in places, more especially along the hanging wall.

Spar island vein.

West Beaver, 140 T., O'Connor.

On the West Beaver property, there are two veins. The "Little Pig" vein was worked some years ago. The other vein is being tested at present. An adit 250 feet long has been driven into the hillside and a shaft about 80 feet deep sunk to meet the adit. The vein averages about one foot in width. There were in the ore-house a few tons of good ore, said to have come from the shaft.

Silver Creek, 95 T., Gillies.

No recent work has been done on the Silver Creek property, but some years ago a tunnel was driven on the vein into the hillside. Where entered upon, the vein was strong, having a width of about two and a half feet, but it gradually pinched to a mere stringer. On sinking, some rich ore was obtained. Work was discontinued, the intention being to re-establish operations on a larger scale, but the general closing down following shortly, the plan was never carried out.

At the Badger, Rabbit Mountain, and others, the workings were in such condition that nothing could be seen.

Stewart and Hewittson's Vein.

During the summer of 1910, a vein was discovered in a quarry within the townsite of Port Arthur, belonging to the above-named contractors. The vein occurs in a fault fissure in the black slates beneath a diabase sill. The vein stuff has a width of about one foot, and is in places rich in argentite and native silver. At the time of the writer's visit it was exposed for only four or five feet in the quarry wall.

Argillite Belt Group

The Silver Islet vein, the greatest producer of the district, occurs in the gray argillite belt. The mine has been closed since 1884. A few other veins have been exploited on the shores and islands of Lake Superior, all of them with little success. Only one of these, the Spar Island vein, is being worked at the present time. After lying idle many years, work was renewed here during the present year. The vein is a strong one, 10 to 14 feet in width, cutting in a direction north 20 degrees west across the gray argillites and two diabase dikes. The veinstuff is chiefly calcite and barite with a little gray copper ore (tetrahedrite), some bornite and pyrite. At times, pockets of sphalerite carrying values in silver are encountered. The mineralization is on the whole not great.

General Summary

It will be noted that special attention was paid to the belt of black slates, the reason being that recent work has made possible the examination of properties there.

It has been mentioned that all of these properties closed with the fall in the price of silver in 1892. The price of silver is still low, but methods of mining and ore-dressing, and more especially, transportation facilities, have been much improved. A few veins had been but recently discovered, but, as is always the case in a slump, they were abandoned with the rest. Whether these veins could be worked under conditions now prevailing is a question which has never been fairly tested. Favoring the possibility is the case of the West End mine, which, after being abandoned with the rest, was re-opened in 1898, producing nearly \$400,000 during five years, presumably with some profit.

The few finds of silver ore that were made in the iron formation division proved to be mere pockets. Veins passing downward from the black slate into the iron formation would be expected to show deterioration in value. Such an experience seems to have been met with in those workings which attained that depth, but the facts are not available. It has been mentioned that the black slate has a maximum thickness of between four and five hundred feet. The belt continues westward from the silver area, finally passing into the state of Minnesota, the thickness of black slate here being 900 feet. This western extension has never been prospected.

The experience of Silver Islet would lead one to expect much from veins in the gray argillite division, but the small amount of work which has been done on several veins has not fulfilled this expectation. It seems improbable that the Silver Islet vein should be unique, and it must be said that the area has never received careful prospecting. Large tracts of land were acquired under older mining laws. This land

is simply held for sale at such time as the work of the bona fide miner may give the land a prospective value. Such a system is decidedly detrimental to the development of the country.

The occurrence of two rich silver camps in Northern Ontario, that at Cobalt and that near Port Arthur, separated from each other by a stretch of 500 miles of Huronian rocks, makes bright the prospect of important silver finds over a large area, now little known.

Production of District

Year.	Value.
Prior to 1887	$3,349,338
1887	190,495
1888	208,064
1889	162,309
1890	166,652
1891	221,120
1892	36,072
1898	51,960
1899	65,575
1900	96,367
1901	84,830
1902	58,000
1903	8,949
Total	$4,699,731

Mr. W. A. Preston, M.P.P., has estimated the production of the individual mines as follows:

Silver Islet	$3,250,000
Silver Mountain, East and West	500,000
Beaver	550,000
Badger and Porcupine	300,000
Rabbit Mountain	50,000
Thunder Bay	20,000
Shuniah	50,000
3 A. and Beck	10,000
Jarvis Mining Co.	40,000
Total	$4,770,000

THE STURGEON LAKE GOLD FIELD

BY E. S. MOORE

Introduction

The first work of which there is any record was done in the Sturgeon Lake Gold field about ten years ago. Since then the reputation of the field has risen and waned several times, as discoveries of gold have been made or better transportation facilities provided.

The writer's first visit to the region was made during the latter part of the field season of 1909, and a summary report on it was published in the 19th Report of the Bureau of Mines. When that report was published it was deemed advisable, on account of renewed interest in the region and the need of a good map of the complicated lake, to postpone the publication of a final report until the following year. To obtain the necessary data for this report the writer was instructed by Mr. Thomas W. Gibson, Deputy Minister of Mines, to spend a portion of the field season of 1910 in this region and to make a detailed map of the northern half of the lake. This map on a scale of 40 chains to an inch was prepared by the use of the prismatic compass and micrometer, and although the lake has an extremely irregular shore line an attempt was made to make an accurate survey of it. On the map there have been laid down all the surveyed claims of which we could obtain records and which could be located, no attempt being made to plot any of the prospectors' claims not laid out by a surveyor. A key map taken from a large map published by the Canadian Geological Survey furnishes an outline of the topography of the whole Sturgeon Lake region and the relative position of the Sturgeon Lake Gold field, and those desiring a map covering a larger area in this district are referred to the Geological Survey map on a scale of four miles to an inch, which was found of much service in my work.[1]

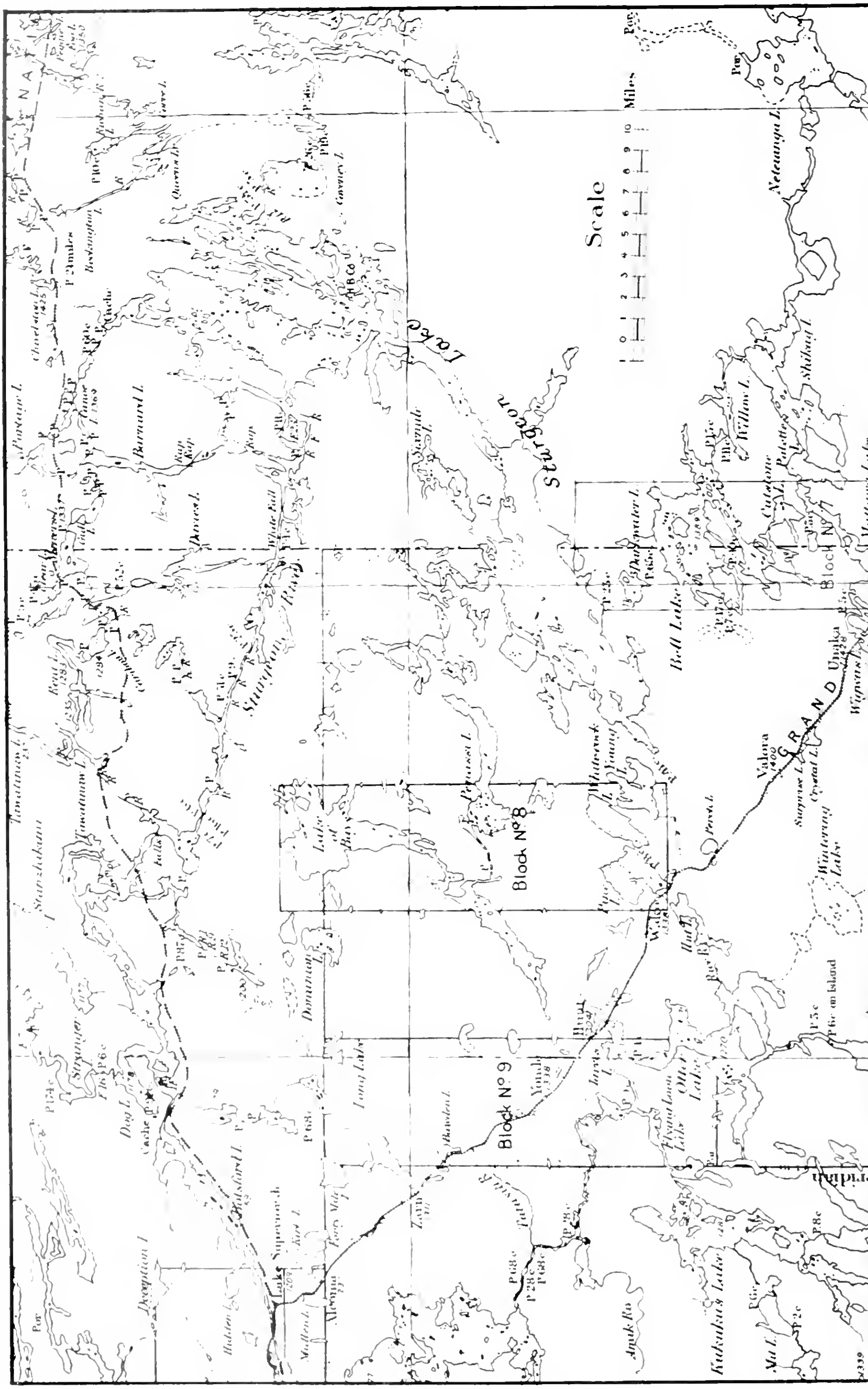
During the season I had as assistant, Mr. Thomas Firth, who performed most of the topographic work, and my acknowledgments are due to him and to Mr. O. Bowles, another member of the party, for their assistance and the very active interest they exhibited in the work. I wish also to express my thanks to many in the region who rendered assistance and favors to our party, especially to Mr. A. L. McEwan, manager of the St. Anthony mine, Captain Cross, Mr. T. K. Barnard and Mr. J. W. Morgan, Mining Recorder at Port Arthur.

The final draft of the accompanying map has been prepared by Mr. W. R. Rogers, topographer of the Bureau of Mines, to whom much credit is due for the pains he has taken in compiling and adjusting the mining claims.

History of the Field

According to Mr. W. McInnes, of the Canadian Geological Survey, who seems to have been the first geologist to describe Sturgeon lake and the geology of its vicinity, gold was discovered on Sturgeon lake in the summer of 1898, when a number of claims were staked.[2] A little later than this the most important deposit of the region, now owned by the St. Anthony Mining Company, and at first known as the Jack Lake mine, was discovered, and in 1901 Dr. A. P. Coleman describes the work which was being done on this property.[3] A little to the north of it the Sturgeon Lake Mining Company had erected a stamp mill and installed machinery on the Dawson property, named after G. Dawson, president of the company. Mining continued, with periods of cessation, at the St. Anthony Reef mine, until 1908, when it ceased, and almost no mining work has been done since, although some new camps and other buildings were erected last summer and underground development work was begun.

[1]Map of Explored Routes in a portion of Northwestern Ontario traversed by the National Transcontinental Ry. between Lake Nipigon and Sturgeon Lake; Canadian Geological Survey; map No. 993.
[2]Summary Report of the Canadian Geological Survey, 1899, pp. 118-120A.
[3]Bur. Min., Vol. XI. (1902), p. 148.



Key Plan showing position of Sturgeon Lake relative to the National Transcontinental Ry. and Grand Trunk Pacific Ry. (L. Superior branch).

During the years 1901-2 the United States Gold Mining Company did considerable work on what is known as the Shore properties, near the west end of King's bay and on claim B. G. 136 on the southwest shore of North bay. Three shafts were sunk on the former property and a tunnel about 50 feet long driven into a hill on the latter.

The work on those properties being unsatisfactory, they were abandoned the next year, and nothing has been done with them since.

Camps were built and shafts were sunk on the Symmes prospect on B. G. 129 on North bay about the same time as those mentioned above. About this time also the camps at the Northern Light and other properties near the northern part of Northeast bay were erected, but soon fell into disuse.

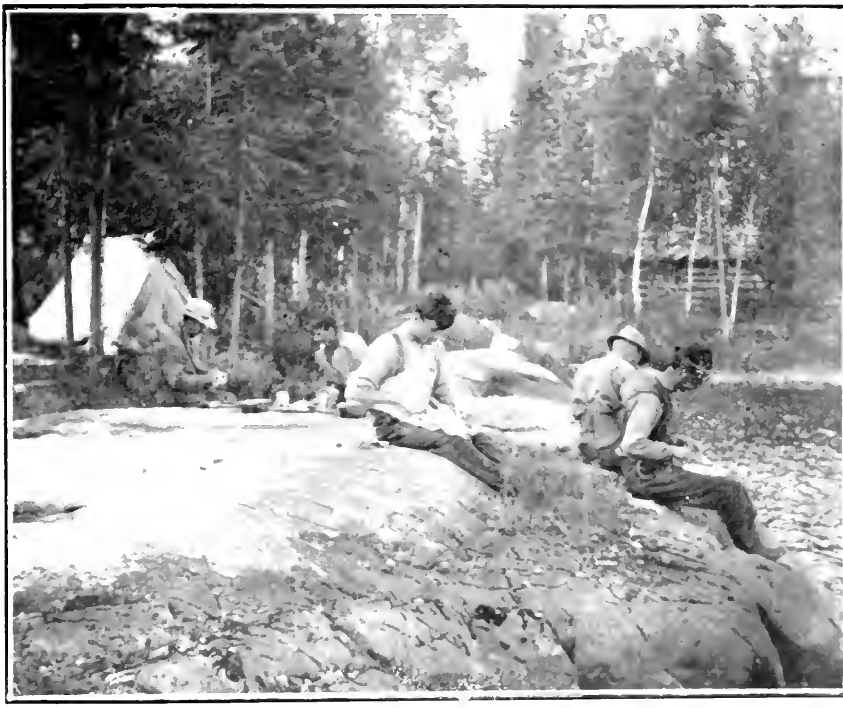


Fig. 1. Our camp at the old D[illegible] mine, Sturgeon lake.

In 1906-8 there was some activity in the vicinity of Belmore bay, where the Belmore Bay Mining Company sank a shaft 260 feet deep and built a three-stamp mill, and the Douglas Mining Company did a considerable amount of development work.

In 1909 prospecting received a new impetus through the construction of the Lake Superior Branch of the G. T. P. and the establishment of steamer lines on the lake for the transportation of materials for railway construction. These afforded facilities for easy access to the region, and a good many prospectors entered the district, but the boom was only temporary. On account of the delightful lake, the ease with which the region can be reached and supplies obtained, it has often seemed that many prospectors have found it a very desirable one in which to spend a summer at the expense of someone else, and this has led to the foolish and useless expenditure of time and money on what has been called development work. Efforts have been made to sell properties that are known to be absolutely valueless. Many large pits have been sunk in rock where there is almost no sign of quartz and no gold in what quartz there is.

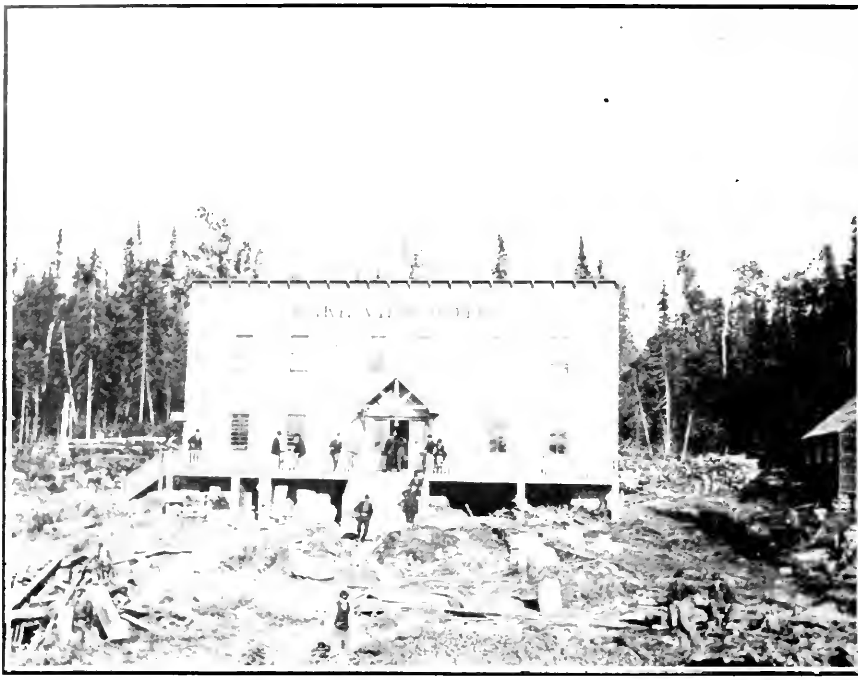


Fig. 2.--Hotel at O'Brien, Sturgeon lake.

Fig. 3.--Steamer on Sturgeon lake.

Besides the writers already mentioned, several others have written geological notes on the Sturgeon lake region. Among these are Dr. W. G Miller, who in 1902 wrote a good account of many of the deposits.[4] W. H. Collins of the Canadian Geological Survey,[5] and E. T. Corkill, Inspector of Mines,[6] have written briefer notes on the mines.

The lake after which the field is named is about 45 miles long, and the northern half is divided into two large arms known as North bay and Northeast bay. It lies across the boundary between the Districts of Rainy River and Thunder Bay, and in 50 degrees north latitude. A spur line about six miles long runs from the lake to the Lake Superior Branch of the Grand Trunk Pacific Railway, at W. O. junction, about 154 miles from Westfort, near Fort William. The field is thus easily accessible, and when the Transcontinental main line is complete it will pass about three miles north of the lake.

Fig. 1.—Sturgeon Lake Hotel, 1909.

Geology

The rocks round Sturgeon lake form an extremely complex igneous series of extrusions and intrusions. There are very few sediments in the area, and none of them form definite geological horizons. The only sediments recognized with certainty were a few patches of graywacké, arkose and dolomite, the former being found in the open cut at the St. Anthony mine, the arkose at the Dawson and Shore mines, and the dolomite on Claim H.W. 705 and on Morgan Island. Besides these there are some masses of a fine grained gray gneiss or schist, which is believed to be partly sedimentary in origin. It is finer in grain, more granular in texture, and as a rule lighter in color than the granite gneiss. It is similar to large areas of rock found by the writer in the Lake Savant area.[7]

[4] W. G. Miller, Bur. Min., Vol. XII. (1903), pp 83-6 and 104 5

[5] W. H. Collins. The Region between Lake Nipigon and Clay Lake. Canadian Geological Survey, 1909.

[6] E. T. Corkill, Bur. Min., Vol. XVI. (1907), p. 60. Ibid., Vol. XVII. (1908), pp. 65-66. Ibid Vol. XVIII. (1909), pp. 81-82. Ibid., Vol. XIX. (1910), p. 79.

[7] Lake Savant Iron Range Area. Bur Min., Vol. XIX. (1910), p 183.

The igneous rocks consist of granites and their metamorphic equivalents, gneisses, aplites, quartz-porphyries, rhyolites, hornblende-syenites, diorites, diabases, basalts, gabbros and porphyrites. Dr. W. G. Miller described boulders of nepheline-syenite which he found near East bay, but we did not locate any of this rock in our work.[8]

On the accompanying map a number of these rocks have been differentiated, but they are so intermingled that only the larger areas of each type could be laid down, and these areas often include small patches of the other rocks. There are represented a few small areas of agglomerate and breccia, which in some cases are crush-breccias and in others probably flow-breccias and agglomerates, the latter consisting of fragmental material ejected from volcanoes.

An attempt has been made to separate these rocks according to their relative geological age, but the only definite arrangement that can be made is on a purely lithological basis. There are no sedimentary rocks in the area which furnish definite geological horizons. The granite along the western portion of the field, designated the

Fig. 5.—Acid granite dikes cutting arkose and biotite-granite gneiss.

Sturgeon Lake granite because of its prominence in the area, is by no means typically Laurentian, and some of the quartz-porphyries are older, some equivalent in age, and some younger than the great mass of the granite.

Many of the greenstones and schists, as well as the quartz-porphyries, are typically Keewatin, but there are some greenstone dikes cutting the granite, and there are many masses of comparatively fresh-looking gabbro and diorite apparently much later than the older rocks of the area, and often cutting the quartz-porphyries, which are younger than the oldest of the greenstones.

Age of the Granite

The age and association of the granite is interesting because of the apparent relation between it and the ore deposits, and of the petrographic character of the rocks. This granite has usually been regarded as of Laurentian age and has

[8] Bur. Min., Vol. XII. (1903), pp. 104-5, and Am. Geol., Sept., 1903.

been mapped as such by previous investigators in this region. It was found, however, that it is not typically Laurentian, as much of it is not gneissic at all and looks like a comparatively fresh rock. The eastern portion of it is porphyritic and in places grades over into quartz-porphyry. None of these features are absolutely opposed to the rocks being Laurentian, but they are not typical of rocks of that age.

It was at first thought possible to separate the granite along the west shore of North bay, where some of it is metamorphosed to a gneiss and in places cut by numerous granite dikes (Fig. 5), from a younger porphyritic granite along the eastern portion of the bay, which contains few of these dikes. The work on the whole area, however, failed to show any means of doing this, and also indicated that the two types pass into one another by imperceptible gradations. In some places the granite has been locally more metamorphosed than in others, giving rise to the patches of gneiss, and the porphyritic phase seems to be due to differentiation influenced by the contact with the Keewatin greenstones.

Fig. 6.—Intrusion of quartz-porphyry into greenstone.

The age of the numerous dikes of granite, felsite and aplite, is doubtful. These dikes were first observed near the northern end of North bay, where they cut biotite-gneiss and a fine-grained gray gneiss or schist, the latter probably of Keewatin age. It was thought that they belonged to the later porphyritic granite, but they were found to be connected with the main mass of the granite in the vicinity, and later, similar dikes were found cutting the porphyritic granite on the east shore of the bay. Dikes of felsite and aplite were also found cutting the greenstones at considerable distances from the granite mass. The assumption that there are granites of two distinct ages in this area is supported by the fact that at Unaka, a station of the G. T. P. Ry., a few miles east of Sturgeon lake, there are distinct granite dikes cutting a typical highly metamorphosed Laurentian gneiss. In this case the granite had been folded and metamorphosed before the dikes were intruded, and this was thought to be the

case on the northwest portion of Sturgeon lake, but the pegmatitic and aplitic character of so many of the dikes suggested that they may have originated as a later phase from the same magma as the granite, in some such order as suggested in the next section of this report.

That some of the quartz-porphyry is older than the granite is shown at the St. Anthony mine, where the latter cuts a schistose phase of the former; and that there is quartz-porphyry of the same age as the granite is shown by the gradation of one into the other. The small area of porphyry near the mouth of the creek draining Couture lake cuts the granite and is therefore younger.

The large mass of hornblende-syenite along the east side of the narrows is younger than the greenstones of the region, and is a comparatively fresh rock, but beyond that nothing can be said about its age. It is not improbable that it is related to the Sturgeon Lake granite and of similar age.

As to the age of the dolomite, little can be said beyond the fact that it is older than the quartz veins which cut it in some places.

Regarding the age of the rocks of the area, it is the writer's opinion that there are basic rocks of ages varying from Keewatin to Keweenawan, quartz-porphyries of Keewatin to at least Huronian age, and that the Sturgeon Lake granite is later than Laurentian and is possibly Huronian in age.

Vein Characteristics

The veins are largely fissure fillings. They are as a rule very irregular, because the cavities were formed along contacts between different types of rock, along planes of cleavage and fissility in schists, and in igneous rocks by unequal cooling and torsion. In one case a considerable fissure was opened along a fault plane at the St. Anthony mine.

The gangue is predominantly quartz, although some calcite and siderite occur. The sulphides are pyrite, chalcopyrite, galena, zinc blende, pyrrhotite and pyrolusite. The ores are largely free-milling. The upper portions of the veins, owing to oxidation and concentration, often show splendid specimens of free gold.

Four stamp mills have been installed in the region, but only one, that at the St. Anthony mine, has handled any considerable quantity of ore. This mine has produced a good deal of ore, but it is difficult to procure records of the quantity and value. Many shafts have been sunk and a great number of test-pits dug on more than two hundred claims which have been recorded in this field.

Mines and Prospects

The United States Gold Mining Company

The properties controlled by this company are locally known as the "Shore properties," from the name of the man who managed them. One of these properties includes the claims A. L. 367 and 368 near the west end of King's bay, and the other B. G. 136 on the south west shore of North bay. On the former of these there are a few old camps, and a two-stamp mill with boilers, crusher and an old vanner. Work was carried on here about ten years ago, and Dr. W. G. Miller describes the workings about that time.[9] He states that this company was the third largest operator during the year, 8 men being employed on the surface, but no mining was done, and shortly afterwards all operations ceased. Shaft No. 1 near the mill was said to have a depth of 100 feet, and No. 3, near the water's edge, 60 feet. There was a combined open cut and tunnel, which ran about 125 feet N. 60° W. into the hill side. No. 2 shaft, which lies back on the hill, was 70 feet deep, but had been abandoned.

The rock on this property consists of greenstone and banded arkose and slate intruded by quartz-porphyry and porphyritic granite which are believed to be related. There is a band of this rock impregnated with pyrite, pyrrhotite, marcasite, calcite and quartz running nearly east and west along the shore of the lake. The porphyry and granite contain considerable pyrite, and the pyrite in the other rocks is evidently

[9] Bur. Min., Vol. XII. (1903), p. 85.

secondary, as it fills cracks in quartz fragments and appears to have replaced some portions of these fragments. The acid rocks are believed to be the source of the metals.

This property has been abandoned.

The workings on Claim B. G. 136 consist of a tunnel which runs horizontally not far below the surface, along a vein for a distance of about 150 feet, making a bend to the north about 100 feet from the exit. The vein is quite irregular, and is in the porphyritic granite not far from the contact with greenstone. The gangue is quartz, and carries some pyrite and a little chalcopyrite, partly altered to malachite. The quartz was dark, slightly opalescent, and does not look unfavorable, though no free gold was seen.

AL 499

On an island in North bay covered by location A.L. 499, and not far east of the last property described, Mr. T. K. Barnard has sunk a shaft and stripped a number of veins. Mr. Barnard has been on this island for seven years, and his beautiful flowers and well-kept cabin deserve special mention. It is probably the best kept and most attractive cabin owned by any prospector in the north.

Fig. 7. Mr T. K. Barnard's camp, Sturgeon lake.

On this island there is a contact between greenstone in the form of altered diabase, green schist and quartz-porphyry, which in places becomes more like granite than quartz-porphyry, and may be regarded as a phase of the granite. The veins occur in the greenstone and schist, in the porphyry and along the contact between the two. The quartz in most of the veins is dark and favourable looking, although one vein appears barren. One of these veins runs nearly across the island. A shaft 25 feet deep and 9 x 7 feet, has been sunk on a group of one large and many smaller veins. In the shaft there is a dike-like mass of porphyry, and there is some evidence of a slip horizontally part way down the shaft, while at the bottom there is a mass of greenstone. As this greenstone is older than the vein it has not intruded it, and although the vein may have pinched here it may reappear on either side of this mass.

There are many little stringers in the quartz-porphyry, suggesting that the fissures had been developed at the time of cooling and contraction of this rock. From one of these little veins some gold was panned, and the dark quartz from the shaft also showed

fair values, but we did not find any visible gold, and the owner stated that it seldom occurred, although this property has had a local reputation for supplying unusual samples of free gold.

The Symmes Prospects

On claim B.G. 139, on the shore of North bay, there are three old camps, and near them some pits. W. G. Miller states in his report that there are two shafts on the Symmes property, which includes B.G. 138 and adjoining claims, about 25 feet apart, and that the southern one is said to be 22 feet deep and the other one 15 feet. He describes the vein as about 9 feet wide, occurring in granite, and consisting of dark quartz carrying iron pyrite, dark sphalerite, and occasionally visible gold. I could not get any definite information in the field regarding these properties, as some of the claims have been abandoned and the Coveney brothers have taken up and partially developed some of the others, which will be described under "The Coveney prospects."

Near the camps on B.G. 139 there are two pits about 100 feet apart and 7 to 10 feet deep on a large white quartz vein. The granite in which the vein lies in the upper portion of the pit as a sort of capping, is much shattered, and the vein is very irregular.

Fig. 8. Island of quartz-porphyry in Northeast bay, Sturgeon lake.

The Coveney Prospects

On A.L. 497, a short distance from the southeast corner of B.G. 138, considerable prospecting work has been done by the Coveney brothers. They have sunk three pits, two of which lie near together, on a large irregular mass of quartz near the contact between porphyritic granite and Keewatin green schists. This mass of quartz appears to form a sort of capping from $1\frac{1}{2}$ to 6 feet thick due to solutions rising from many cracks in the shattered granite and spreading out along some horizontal line of weakness, probably between the greenstone above and the granite beneath, and then exposed by the removal of the greenstone by erosive agencies. The bottoms of the pits show very little evidence of a continuous vein. Where stripped, small dikes of granite are seen cutting the schist, and numerous stringers of quartz occur in both granite and schist.

The largest pit is in the form of a trench about 50 feet long, 10 to 15 feet deep and

8 to 10 feet wide. Some of the ore taken from this pit was described by Mr. D. Coveney as containing the following assay values:

Silver	$25 per ton.
Gold	$6 "
Copper	$2 to $3 "

Fig. 9.—Coveney's test pit, Sturgeon lake.

One of the most highly mineralized specimens, taken by the writer and analysed by Mr. N. L. Turner, Provincial Assayer, showed the following values:

Gold	0.20 oz. ($4.00) per ton.
Silver	22.72 oz. ($11.36) "

The vein is fairly well mineralized with chalcopyrite and pyrite. The latter is sometimes in cubes one-half an inch in diameter, and in some places the pyrite has been dissolved, leaving cubic cavities in the quartz filled with iron oxide.

The contact between Sturgeon Lake granite and Keewatin schist runs nearly north and south in this vicinity, and about 100 paces south along the contact there is another pit on a large quartz vein. This pit is about 12 feet deep and varies in horizontal dimensions from 10 x 7 feet at the top to 6 x 5 feet at the bottom. There was a little water in the pit, and at the surface of the water the vein widens out to practically the

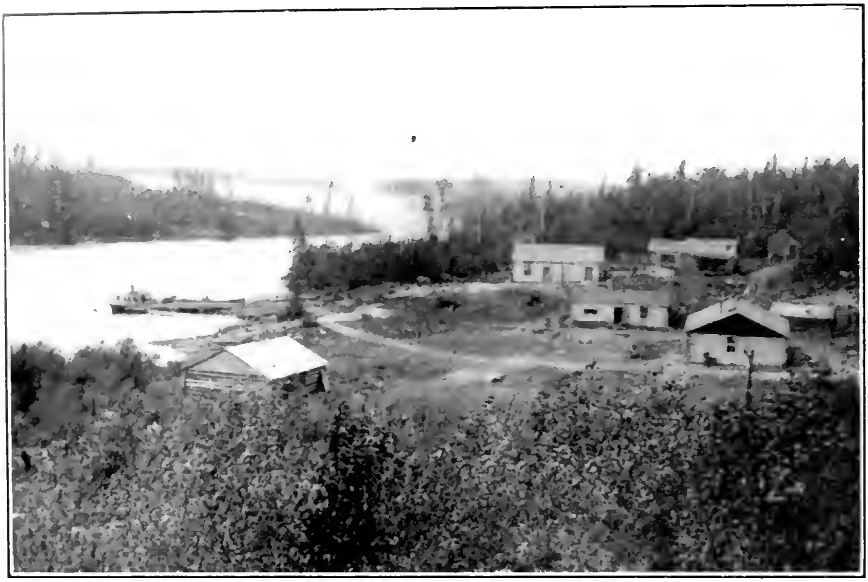


Fig. 10. St. Anthony mine camps, Sturgeon lake.

Fig. 11.—St. Anthony mine, Sturgeon lake, showing stamp mill, power house and shaft house.

full width of the pit. The upper portion of the vein is very irregular and is mixed with bands of schist. It strikes 160°, dips 80° W., and where stripped can be traced 150 feet up the hillside, where it either pinches out or is turned off in another direction by a change in the strike of the schist, which at this point changes in strike to a north-east direction. Throughout this 150 feet it keeps its width well, and the footwall is fairly distinct.

The St. Anthony Mine

The St. Anthony mine is situated on claims B.G. 151 and 152 on the west shore of Couture lake. The camps (Fig. 10) are located on B.G. 154 and 168 on St. Anthony bay, a small indentation in the shore of North bay of Sturgeon lake. The camps, as well as some of the buildings at the mine, have been renovated during the past summer, preparatory to the carrying out of further development work at the mine.

This property, which is by far the most important one in the district, was located about ten years ago, when it was known as the Jack Lake mine. It also goes by the name of the St. Anthony Reef, because of the idea held by some that its surroundings suggested a reef rising above the water of Couture lake. It has been controlled for some time by the St. Anthony Mining Company, and was worked from the year 1903 until 1908, when it was closed down. During 1907 and 1908 Mr. J. Steele worked the mine under option. The present manager of the company is Mr. Arthur L. McEwan, to whom I am much indebted for his hospitality to us while working in the vicinity of the mine.

The buildings at the mine (Fig. 11) consist of a ten-stamp mill and amalgamation plant, boiler, engine and shaft house, carpenter shop and blacksmith shop. The sulphide concentrates from the mill have been stored pending better shipping facilities.

The general plan of the mine and the geology in its immediate vicinity is shown on the accompanying sketch map (page 117). The mine workings consist first of an open cut extending almost north and south along the main vein from Couture lake (Fig. 12). This cut is over 300 feet long and reaches a maximum depth of 40 feet and width of 25 feet. The width varies from about 10 to 25 feet, and the greater portion of the material removed was milled. In the bottom of the open cut shaft No. 3 is found, and it extends 100 feet below the surface. About 220 feet north of this shaft No. 2 has been sunk and a drift connects the two shafts, most of it lying along the vein. At the bottom of No. 2 a cross-cut runs west 30 feet to pick up the vein, and then a drift south 67 feet and another cross-cut east to the north and south drift between the shafts. A cross-cut is said to extend east 125 feet from the bottom of No. 2 shaft. The hoisting is done from this shaft, which is timbered.

From the west end of the 30-foot cross-cut from shaft No. 2 a drift runs north 180 feet to an upraise known as No. 1 shaft, and from the opening a drift is said to continue further north 160 feet. No mine maps were available at the time of my visit, and these figures are compiled from several sources.

Besides the open cut there are on the surface a number of pits as indicated on the sketch map, but none of these are very extensive. The rocks in the vicinity of the mine consist of Keewatin greenstone, schist and schistose graywacké, intruded by quartz-porphyry, and the whole intruded by the later Sturgeon Lake granite. The granite in this vicinity is porphyritic and highly altered by hydrothermal action, where chemically active waters have acted on the rocks. The main vein runs in the granite close to the contact for some distance, and then leaves the granite and extends out into the schists. There seems to be good evidence that when the granite cooled and shrunk, the adjacent rocks were broken and shifted so that a fissure could be filled with quartz and calcite. From the appearance of the walls on the sides of the open cut it looks as if the rock on the east side of the fissure moved north and that on the west side south. At the time this large fissure was formed countless smaller ones were developed, so that there is a zone about one-quarter of a mile wide, more or less streaked with quartz veins, and in places the walls of the main fissure become indistinct in the granite (Fig. 22). In the walls of the veins the granite has been so altered that most of the feldspar has

disappeared, and the rock has turned into a greenish-yellow protogine, consisting almost entirely of quartz and muscovite.

The gangue in the granite and schist is largely quartz, but some calcite occurs in both rocks and in greater proportion in the latter. Some siderite is also present where the vein cuts the schist. In the open cut in the schist, the walls are distinct, although the quartz is often distributed in narrow veins along the planes of cleavage, and the whole mass from wall to wall contained more or less gold.

The minerals in the gangue are free gold, pyrite, chalcopyrite, sphalerite and galena. Beautiful specimens of free gold have been obtained from this mine. Much of the ore is free-milling, but with depth the sulphides appear more abundantly. The ore from the schists contains less sulphides than that from the granite, and

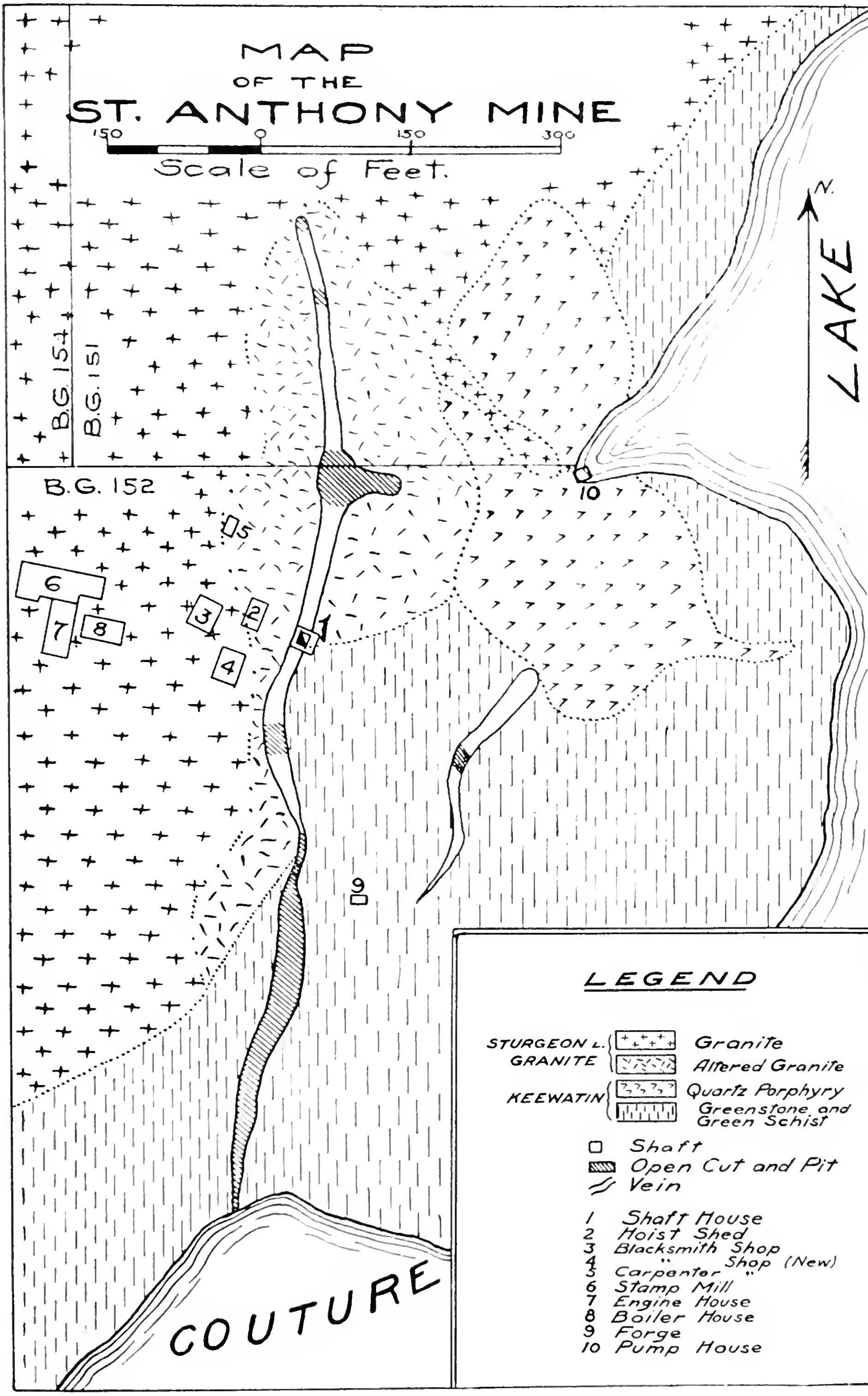
Fig. 12. Open cut at St. Anthony mine.

this seems to be due to the greater ease with which oxidizing waters percolate the schists. The writer was informed while at the Athabasca mine, near Nelson, B.C., that similar conditions existed there where the ore occurs in porphyritic granite and schist.

No assays of the ore were made by the writer, but the manager states that much ore was mined which ran as high as $85 per ton, and that there is still in the mine a good deal of ore which will average $12 per ton. It is not unlikely that with depth the quartz veins will become less clearly defined in the granite, it being probable that most of these veins were formed in the outer and upper portion of the granite magma when it cooled, before the mass as a whole was completely solidified.

During the past summer new interest was taken in this property, and considerable work was done in the way of putting up new buildings and making a start at development work by sinking in No. 3 shaft.

This property has been described by other writers, and references are given in this report in the section on the history of the field.


MAP
OF THE
ST. ANTHONY MINE
150 0 150 300
Scale of Feet.
N.
LAKE
B.G. 154
B.G. 151
B.G. 152
COUTURE
LEGEND
STURGEON L. GRANITE
Granite
Altered Granite
KEEWATIN
Quartz Porphyry
Greenstone and Green Schist
Shaft
Open Cut and Pit
Vein
1 Shaft House
2 Hoist Shed
3 Blacksmith Shop
4 " Shop (New)
5 Carpenter "
6 Stamp Mill
7 Engine House
8 Boiler House
9 Forge
10 Pump House

The English River Gold Mining Company

On location B.G. 157 is what is known as the Dawson mine, now owned by the English River Gold Mining Company, and formerly controlled by the Sturgeon Lake Mining Company. Like the St. Anthony, it is situated near the contact between the green schists and granite, but instead of lying on the main contact, it lies on the contact between bands of schist and arkose cut by the granite. There are here a number of pegmatite dikes, in some parts composed of about half feldspar and half quartz, and in other parts consisting largely of one or the other.

The gangue is quartz, and the ore minerals found were galena, sphalerite, pyrite and chalcopyrite. Good specimens of free gold are said to have been found, though we were unable to find any on the dump.

The workings include a shaft, open cut and some pits, the former being full of water. The shaft is said to be 64 feet deep, and the open cut is about 70 feet long, 10 feet deep and 5 to 6 feet wide. Much of the country rock is included in this width.

The buildings include a mill containing ten stamps and other equipment (Fig. 13), but the mill has been long idle.

Fig. 13. Sturgeon Lake Gold Company's stamp mill.

Other Prospects on North Bay

Besides a large number of pits, too numerous to mention individually, there are two more shafts near the east shore of North bay. One of these is on claim H.W. 704, along the contact between granite and green schist. This shaft is about 48 feet deep, and was sunk by William Lediet on an irregular quartz lode, which is made up of stringers and lenses of quartz in the schist extending the width of the shaft. The quartz and schist are impregnated with pyrite, but we did not find any visible gold.

East of claim H.W. 691, near the north end of the bay, there is a shaft about 53 feet deep on a very irregular vein of quartz and greenstone.

Just south of this shaft there is a large pit on an irregular mass of quartz. The pit disclosed quartz for a distance of 18 feet. Many smaller pits were also found in

this area, and on one of them is a vein of calcite, carrying large radiating crystals of tremolite.

On claim H.W. 697, southeast of the Fawson mine, known as the "White Prospect," there is a mass of quartz broken up by prospectors. This large mass appears to have been separated from a vein somewhere in the vicinity and was probably moved to its present position by a glacier. It is very difficult to say where the mass originated, and it seems to lie on green schist. There is swamp to the north and west. As there is a large vein whose strike would carry it through this swamp, lying about 100 paces to the southwest, it is probable that the mass of quartz has been broken from this vein a little to the north. The vein where exposed is about 15 feet wide, and consists of what appears to be barren white quartz. The broken quartz looks more favorable as a carrier of gold, and although two of us on two separate occasions spent considerable

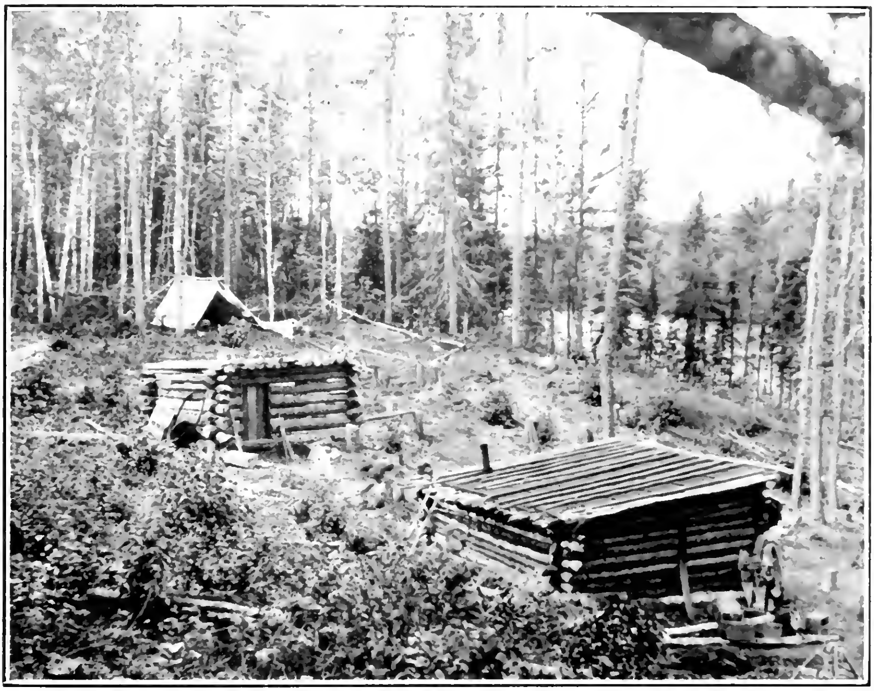


Fig. 14. Peter King's camp on Couture lake.

time in searching the fragments for specimens, we were unable to find any visible gold. Dr. W. G. Miller in his report on this prospect states that he had no difficulty in finding "shows of gold," and apparently the attractive specimens have all been carried away.

Prospects on Couture Lake

There are a great number of prospects in the vicinity of Couture lake, but it is possible to describe only a few of them here.

On the large island northeast of the St. Anthony there are some large quartz veins in schist. None of these have been developed, and Mr. Miller has already described them. One of these gave an assay of $2.75 per ton in gold.

On claims A.L. 656 and 657 there are a number of pits and one shaft. These are controlled by Messrs. King and Frazer. The shaft is said to be 75 feet deep. The vein of quartz and calcite is about 8 inches wide, and has a pretty distinct hanging wall. It carries some nice specimens of visible gold. The vein can be followed over a portion of two claims, and although it is largely in green schist, it is closely associated with a

narrow band of comparatively fresh-looking quartz-porphyry, in which is some of the quartz, and some of it along the contact between it and the schist. The vein shows a tendency to break up into stringers in some places, and is small, although the quartz looks favorable as a carrier of gold.

To the north of the shaft, on some claims worked by Mr. Fawcett, are a number of pits on veins which in some places show visible gold. North of these claims there are a good many pits, most of which are of no interest.

On the west side of the lake, on claim A.L. 662, there is an old shaft at least 20 feet deep, containing a good deal of water. The vein is about 2 feet wide and dips 30 degrees west. It fills a fissure between a footwall of schist and a hanging wall of altered graywacké. The vein is mineralized with chalcopyrite, galena, sphalerite, pyrite and a little pyrrhotite. A little free gold was found in some specimens of quartz believed to have come from the shaft.

Prospects around Ouillette Lake

There are a large number of prospects in the vicinity of Ouillette lake, lying north of Couture lake. Many of these consist of little pits of no importance, but the Ouillette Lake Mining Company, with headquarters at Sault Ste. Marie, Ontario, have done much prospecting work on nine claims northeast of the lake. Outside of the two old locations S.V. 421 and 422, none of the claims have been surveyed, but they adjoin on the east and south.

One pit about 25 feet long runs across a mass of schistose diorite, and the rock is cut up with stringers of quartz. The quartz carries considerable pyrite and pyrrhotite, and a number of specimens of free gold were seen.

In another pit about 15 feet long and 7 feet deep a mass of white quartz stringers about 10 feet wide may be seen lying along the hanging wall. The rock has about the composition of diorite. On the surface near this pit there is a quartz vein about 3 feet wide which may be connected with the mass already described. It pinches down to about 20 inches in a pit 10 feet deep.

On location S.V. 422 there is a pit on a large mass of quartz. The pit is about 14 feet wide, and the quartz extends almost across it.

On another claim a mass of stringers appearing on the surface unite in a pit to form a vein about 8 feet wide.

The rock in which the veins occur is largely coarse greenstone, the gangue is mostly quartz, and the other minerals in the vein chalcopyrite and pyrite. The veins in places form some of the largest in the region, and some of them carry gold, but they show a tendency to break up into small stringers or otherwise become irregular.

The Northern Light Mine

What is known as the Northern Light mine is situated on location H.W. 694, near the northern end of Northeast bay. There are a number of old camps at the lake shore and the shaft is a little over a quarter of a mile to the north. This shaft, which is timbered, was nearly full of water and its depth could not be ascertained. The vein is not exposed on the surface, so nothing could be learned beyond the fact that the quartz from the shaft varies from dark to almost pure white, and is mineralized to a small extent with pyrite and chalcopyrite. About 50 paces to the west a pit 12 feet deep exposes a vein 6 feet wide. The veins here are in schist and diorite.

This property has not been worked for some years. Last year it was restaked.

The Powell Property

On the west shore of Northeast bay, on Claim A.L. 701, there is a deposit locally known as the Powell property. Last summer it was developed for Mr. Beidelman under the management of Mr. Atwood, who was formerly with the Douglas Mining Company. The workings lie on a vein, consisting of attractive-looking quartz, beginning near the lake shore and running a little west of south. There are a number of pits, and two

of them were about 25 feet deep, but neither was timbered at the time of our visit. The rocks consist of a complicated mixture of quartz-porphyry, gray schist and greenstone, and the vein lies sometimes in one rock and sometimes in the other, and in places along the contact between the two. It varies in width from 2 to 15 inches, and frequently breaks up into stringers, especially at the contact between different types of rock. The quartz is well mineralized with pyrite and chalcopyrite, the latter frequently altered to malachite and azurite. We had no difficulty in finding good samples of gold at a depth of 20 feet. These gold specimens are doubtless due to the secondary enrichment process, as they occur in association with the secondary carbonates of copper.

Near the pits described there are a number of smaller ones on this same vein, which fingers out a little farther south.

Other Deposits on Northeast Bay

On the long point running south, just west of the island covered by S.V. 414, Mr. George Day has staked a number of claims which have not yet been surveyed. On these claims there are some pits on irregular quartz veins in quartz porphyry and along the contact between the quartz porphyry and green schist. The quartz is often disseminated in the porphyry, and appears in places like veins filling cracks in a partially cooled molten mass, though the veins may be later impregnations by hot solutions along lines of weakness. The rock is usually much decomposed along the veins, while the veins and rocks, especially near the fissures, are impregnated with iron pyrite, in some places with cubes one-quarter inch in diameter. In one place a beautiful specimen of gold was seen in a space left by the removal of one of these cubes, and in the oxidized and decomposed rock free gold could be found by panning. Gold in any quantity seems to be limited largely to the upper portion of the deposits which have been oxidized, and it seems probable that a considerable amount of the quartz may have been collected into these veins by the partial decomposition of the surrounding rocks and the segregation of the quartz under the action of organic acids. The organic acids, no doubt, have had a good deal of influence in dissolving and concentrating the gold which would be freed from mechanical union with the pyrite by the oxidation and removal of the pyrite in the form of ferrous sulphate.

Many other small deposits occur in Northeast bay, but they seem much alike and too numerous for description.

Prospects on Belmore Bay

Since the year 1906 the region around Belmore bay has attracted considerable attention, as there are many veins within about three miles of the lake. The Douglas Mining Company have camps on the east shore of the bay and have sunk a couple of shafts (Fig. 15). On claim P. 7 there is a shaft said to be 22 feet deep on a vein varying in width from 3 inches to 2 feet. A test-pit near by shows stringers running through the schist. On the same claim and 98 paces distant from the 22-foot shaft there is another one 73 feet deep on the same vein. The rock from the bottom of the shaft consists of gray to white quartz scattered through schist and mineralized with chalcopyrite and pyrite.

There seems to be little galena or zinc blende in this region, and the same can be said of the deposits on the northern part of Northeast bay, while around Couture lake and North bay these minerals seem to be more common.

On what is called the Ruby property owned by the Douglas Mining Company there is a shaft said to be 30 feet deep on a mass of quartz stringers about 4 feet wide, in dark greenstones varying in composition from diabase to diorite. North of this shaft 100 feet and on the same vein is a pit about 22 feet deep where the vein varies in width from 3 inches to 2 feet. The veins run in a general northeast direction with the strike of the rock and with a dip 60 degrees northwest.

The gangue here is quartz of good quality and calcite. It contains pyrite and chalcopyrite, and specimens of free gold were seen in calcite and quartz.

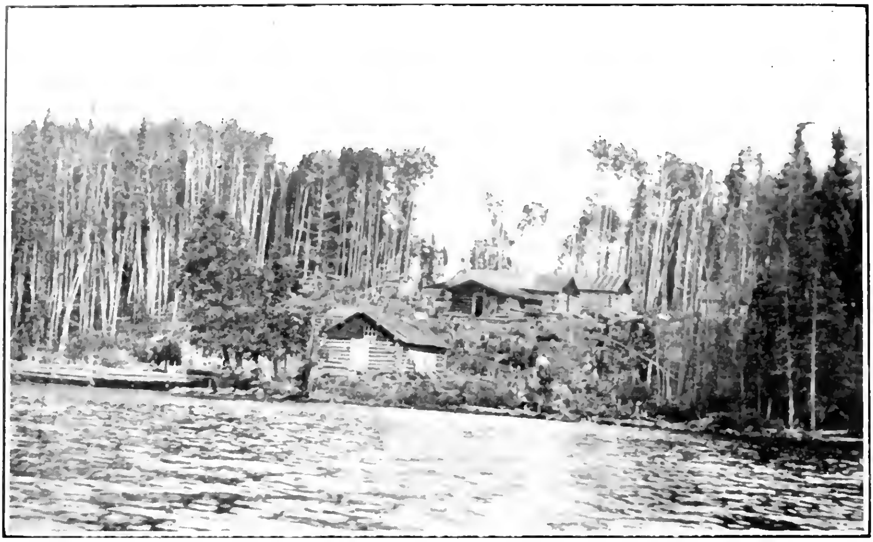


Fig. 15. Douglas Mining Company's camp, Belmore bay, Sturgeon lake.

Fig. 16.—Belmore Bay Mining Company, stamp mill, 1909.

The other company which has done much work in the vicinity of Belmore bay is the Belmore Bay Mining Company, which owns a number of claims just east of the lake. It is said that the shaft near Mud lake, where the camps are situated, is 260 feet deep, and very little ore came out of it. A three-stamp mill has been erected on the shore of the lake, but it did not run long. (Fig. 16.)

Besides the properties described, there are many prospects unnecessary to mention, as most of them are pits on small veins or stringers and a description of one serves for almost all. The rocks in the area are mostly coarse greenstones, not as a rule very schistose, syenite porphyries, quartz porphyries, rhyolite tuffs, and plagioclase porphyries with very large phenocrysts sometimes an inch in diameter. The veins are as a rule very irregular, frequently breaking up into stringers, pinching out or expanding to form masses several feet in width. The metallic minerals are predominantly chalcopyrite and pyrite, with considerable pyrolusite in some places.

Free gold was seen only on a few claims. Some of the veins are associated with aplite and felsite dikes. In one case an aplite dike cuts a syenite porphyry, and near it there are crystals of ilmenite. The rock has been brecciated, and the cracks filled with calcite, carrying chalcopyrite and pyrite. The ilmenite may have been developed as a contact metamorphic mineral.

On Morgan island, just west of Belmore bay, is a mass of rhyolite tuff in places, impregnated, especially near its contact with quartz porphyry, with calcium and iron carbonates, which are mineralized with copper and iron pyrites and galena. The tuff, in a band about 100 feet wide, is composed of angular fragments of rhyolite, and the whole mass is reddened by the alteration of the iron-bearing minerals. This deposit has not been found to carry gold to any extent.

On East bay are a number of abandoned prospects, and on the east side of the narrows about five miles below Sturgeon lake hotel there is a pit on a vein of calcite. Associated with the vein there are besides calcite, apatite, tourmaline, hornblende, zircon, pyrite and chalcopyrite and, it is said, values in silver.

As there are in the Sturgeon Lake Gold field hundreds of pits, many of them of no importance and the majority of them having characters in common, it is impossible to describe them all, and it may be that some left unmentioned are as important as some of those described. An attempt has been made to indicate on the accompanying map the shafts and many of the pits, but many pits and strippings have necessarily been omitted, as it would require too much detail to plot all of them.

Economic Possibilities of the Sturgeon Lake Gold Field

Having spent considerable time in studying this field it might be well for the writer to express, from a geological standpoint, his opinions regarding its future.

A study of the region shows that gold is widely distributed, and that one can locate a vein, small or large, in many parts of the area. These veins are, however, as a rule, very irregular and uncertain, not having been formed by any widespread movements which opened extensive fissures, but rather by cooling and shrinking of igneous rocks and slight movements along contacts and cleavage planes. The fissure at the St. Anthony is the only one which can be regarded as an important exception to this rule, and it is the only deposit which has given promise of really making a mine.

While this area has been remarkable for the large number of fine specimens of free gold, these have been the products of secondary enrichment and concentration, and are not likely to continue to great depths. With the absence of much free gold at depth, few of the veins show a sufficient increase in the sulphide ores to counterbalance the diminution of the free gold. As the region has for so long been exposed to erosive agencies, it is probable that much material from the upper portions of the veins has disappeared, and with it considerable gold. The low relief and the scarcity of streams are also against the possibility of valuable placers being found.

Much unprofitable work has been done in the area, partly because many of the prospectors lacked experience, and partly because, as already mentioned in this report,

some men having charge of the work were doing it at the expense of others. While there are plenty of veins in the region, many mere stringers of quartz have been exploited without any justification, largely because the region is easily accessible and an attractive one in which to work. In the future those who wish to carry on proper exploratory work should profit by the experience of most of the other companies which have operated in the region, and not build stamp mills before they have enough ore in sight to justify such an expense.

Petrography

This section of the report is devoted to detailed descriptions of some of the most interesting rocks of the Sturgeon Lake field and these are given for their scientific rather than economic interest.

Greenstones and Schists

The greenstones of the area comprise a great assortment, among which are many altered diabases, diorites, gabbros and porphyries of basic composition. These porphyries in places show phenocrysts of plagioclase feldspar which are of unusual dimensions. In one specimen the feldspars were somewhat elongated by pressure and one phenocryst measured 2½ inches by 1½ inches; another was 3 inches long and 1 inch wide. The surface of the feldspar shows a pink color due to alteration. Under the microscope the rock is found to be so completely altered to chlorite, uralite, calcite and kaolin that no sharp line marks the boundary of the feldspar crystals. Although many specimens were found which showed large phenocrysts, the dimensions given above represent the largest.

Agglomerates and Breccias

A few patches of these rocks are indicated on the accompanying map. It is hard to distinguish some of them from conglomerates, since they have become schistose. Some of these breccias show rounded and somewhat spherule-like masses of greenstone, which may be due to the rolling and breaking of lava when flowing and cooling, and they may be flow-breccias. Other types seem to be crush-breccias, as angular fragments of a quartz porphyry and rhyolite occur in a matrix which the microscope shows to be composed not of sedimentary material, but of the same igneous rock in a schistose and fractured condition.

Quartz Porphyries and Related Rocks

This group includes a series of fine-grained and porphyritic acid rocks consisting of rhyolites and alkali-feldspar porphyries, with some of their metamorphic equivalents. Most of them are very monotonous types for study. These rocks are supposed to be all more or less intimately related, and to belong to the same petrographic province. One item of interest was the presence of blue quartz grains near the contact between the quartz-porphyry and greenstones, and as stated in a discussion on this phenomenon in a report on the Tip Top copper mine, found in another part of this volume, these are believed to be due to contact action. The color seems to be caused by a large number of very small mineral inclusions in the quartz which are in diameter less than one-half a wave length of light. A specimen of rock taken at the Tip Top mine showed grains of blue and colorless quartz, and under the microscope the blue grains were found to contain many more inclusions than the colorless grains. The blue grains invariably have an opalescent appearance, and it is probable that they contain some water of crystallization. It is also probable that sudden cooling may have prevented the full development of the phanerocrystalline texture, and caused the cryptocrystalline texture to be assumed and with it a rounded grain instead of a crystal with distinct outline.

There are some fine grained gray biotite-gneisses and schists in this area, which are similar to those described in the Lake Savant Iron Range Area as probably equivalent to Lawson's Couchiching.[10] These rocks can be found grading into the fine

[10] Bur. Min., Vol. XIX. (1910), pp. 183-4.

grained acid igneous rocks, and are believed to be formed in most cases by the shearing of the latter and in other cases from the sheared weathered products.

The presence of much pyrite in portions of these acid igneous rocks is a characteristic feature. This pyrite often appears to be pyrogenetic, but in many other cases it is found only along cracks in such a way as to suggest an extraneous source.

Hornblende Syenites

Lying along the eastern shore of the upper portion of the narrows on the lake, there is a large mass of rock which in appearance much resembles a light colored gabbro and has been mapped as gabbro on the Canadian Geological Survey's map. It appears much darker in some parts than in others, but in all the specimens examined the feldspars appear to be of the potash species, and one section showed a very little quartz, so that the rock is a syenite. It has much the appearance of some nephelite syenites though microscopic observations failed to show the presence of any nephelite.

The megascopic characters of the rock are a gray color, phanerocrystalline texture, crystals of pyrite, hornblende and good cleavage faces of feldspar resembling plagioclase, but lacking any sign of striations due to twinning.

Under the microscope one section is composed of the following minerals: Orthoclase, microcline, green hornblende, a little biotite and a small quantity of mica the pleochroism of which would identify it as zinnwaldite. The relation of this mica to the other minerals suggests that it has been introduced into the rock from an external source. Titanite in prismatic form and in acute rhombic sections is fairly common, and small crystals of it are frequently enclosed in the crystals of hornblende. A considerable amount of topaz is present and it shows as a colorless, slightly higher bi-refringent mineral than quartz, filling spaces between the feldspars and in places appears to have replaced portions of these minerals. Fluorite varying in color from blue, violet to colorless is quite common. It occurs in some cases as irregular streaks, but also as little cubes. It is found as small crystals in orthoclase, fills holes in topaz, and occupies cracks in the other minerals or the interstices between various crystals. Apatite is found in small crystals, and pyrite and magnetite in small quantity. Other thin sections show orthoclase, microcline, green hornblende, a little albite, small crystals of augite, apatite, a little tourmaline, considerable titanite, calcite, fluorite, topaz and a small proportion of quartz.

As mentioned in a previous section a pit in the syenite reveals a calcite vein with which are associated apatite, tourmaline, hornblende, zircon, pyrite and chalcopyrite.

In the presence of so many fluorine, boron, and titanium minerals we have good evidence of rather extensive fumarole action. On the cooling of the magma, fracturing on a small scale must have occurred and permitted the boron and fluorine gases to rise through the rock and replace some of the other minerals by new minerals. The quartz and calcite veins would be due to solutions filling some of these cracks.

On account of certain petrographic similarities between them it seems probable that these syenites belong to the same petrographic province as the granites a little farther north, but represent a more basic phase of the parent magma.

Quartz and Calcite Veins

In the quartz and calcite veins of the area there are two interesting mineralogical occurrences. A small calcite vein cutting greenstone on a claim a short distance east of the north end of North bay is full of radiating aggregates of tremolite crystals. The crystals are in sheaf-like bunches, are greenish gray in color and some of them as much as 2½ inches in length. They have a columnar form, furrowed faces and good cleavage. In the calcite there is a little quartz vein with fine needles of greenish actinolite. A somewhat banded arrangement of the materials in the vein suggests that cracks were formed in the calcite, along which the quartz was deposited and the actinolite and tremolite developed by metamorphism.

In a quartz vein from the vicinity of Belmore bay there is siderite, and in the quartz some very thin needles about 1/4 inch in length which are considered to be crystals of rutile.

Sturgeon Lake Granite

From the petrographic standpoint the granites in the Sturgeon lake region are the most interesting the writer has met in the northern fields. The special features in these rocks are the porphyritic texture and the graduations from porphyritic granite to quartz-porphyry, the hydrothermal alteration which they have suffered and the differentiation which may have produced a series of dikes found cutting the granite. The question whether these dikes may be regarded in all cases as simply a later phase of the magma which formed the rocks they cut, or as a distinctly later granite, is difficult to decide, as some of them certainly appear to be of pegmatitic and aplitic character.

Fig. 17. Inclusions of greenstone in granite, where the former has been brecciated by the latter.

Beginning on the northwestern part of North bay just below Trapper's Cabin, specimen 312 was taken from a medium coarse grained, very light colored granite dike, which under the microscope was found to be a biotite granite consisting of a large amount of quartz, some biotite and feldspar which is chiefly albite or the zonally-built sodium-calcium variety. In composition it is high in soda, and much like that of some of the porphyritic granite farther east. Specimen 313 is from a clear cut dike of very acid granite intruding a dark very fine-grained biotite gneiss. The dike consists chiefly of quartz and orthoclase, and is much more acid than the gneiss. Another specimen (No. 316) is from a dike 1 1/2 inches wide, consisting of fine grained granite cutting a gneiss containing much biotite. Under the microscope the dike in places shows clear cut edges and in other places they are indistinct. The proportions of feldspar and quartz are almost the same in the dike and gneiss, and they have both suffered about equally from alteration.

The observations made on these rocks in some cases suggest gneiss and dikes of two distinct ages, while other observations seem to point to the gradation from the condition mentioned to those in which enclosing granite is not gneissic. The contacts between the dikes and enclosing rocks are not distinctly marked off, and the dikes have all the characters of pegmatites. On "Gull Rock," a bare granite island in North bay, a coarse grained biotite granite is cut by a small dike of fine grained granite without distinct walls, and the cooling of the dike does not seem to have been much influenced by the surrounding rocks. The coarse granite is porphyritic and highly sodic in composition, as the large feldspars are mostly albite and the zonally-built sodium-calcium variety. The feldspars are more typical of a granodiorite than a granite, but there is much quartz. As in most of the granite in this region there is much epidote derived chiefly from alteration of the feldspars.

On King's bay there is a good example of the transition from porphyritic granite to quartz porphyry, and it was found that there was a good deal of quartz porphyry in the Sturgeon lake field which was of the same age and developed as a phase of the granite under the influence of the contact of the granite and greenstone or schist. Three specimens were taken (Nos. 323, 325, 326), which show quartz porphyry and granite porphyry, while near by was porphyritic granite.

In the granite porphyry the ground mass is fine grained but holocrystalline, and consists of orthoclase, quartz, epidote, muscovite and chlorite. In it are large phenocrysts of feldspar and a few of quartz and biotite. The feldspars are mostly albite or zonally-built sodium-calcium feldspars, so the granite is of a basic type. The quartz phenocrysts show some unusual examples of re-absorption by the groundmass.

It is observed that the porphyritic portions of the Sturgeon lake granite are confined largely to the vicinity of the contact with the Keewatin greenstone, and it is found also that the porphyritic portion is on the whole of a more basic type, as regards the composition of the feldspars, than the other part of the rock. This composition often approaches a granodiorite. It is possible that this difference in composition may be due, in part at least, to the absorption of much of the basic greenstone. There seems to be good evidence of the action of "stoping" in the vicinity of the contact around the St. Anthony mine where so many fragments of greenstone have been included in the granite (Fig. 17). Although many of these fragments show almost no sign of the action of the hot granite upon them outside of the development of actinolite at the edges, since they are angular and the edges are not rounded, many others must have been included more deeply in the hotter portion of the magma and been melted.

GOLD FIELDS OF LAKE OF THE WOODS, MANITOU AND DRYDEN

BY ARTHUR L. PARSONS

Introduction

In accordance with instructions received from Mr. Thomas W. Gibson, Deputy Minister of Mines, the writer left Toronto on May 7th, 1910, by the Canadian Pacific railway, for Kenora, to report on the gold mines of the Lake of the Woods, Manitou, and Dryden areas, and to make such further geological investigation of the region as could be accomplished in the field season. Mr. Ellis Thomson, of Toronto, acted as assistant throughout the season, paying particular attention to topographic work while at the same time making geological observations, and his services were of the highest value. During the month of May Mr. H. K. Slater, of the Mysore Geological Survey, accompanied the party as a guest, giving many valuable suggestions concerning the relations of the rocks.

In this report petrographic detail has been avoided, and, so far as possible, only those terms are used in designating the rocks as are employed in the reports of Dr. Lawson. In preparing the maps, the effort has been made to make the determining factor of classification depend upon the appearance in the field rather than upon the finer petrographic distinctions to be made in the laboratory, but in a few cases where the line of distinction could not easily be drawn in the field, the result of microscopic examination has been incorporated. The maps for the report have been prepared by Mr. Thomson.

Lake of the Woods and Shoal Lake

The geology of Lake of the Woods and Shoal lake has been worked out in detail by Doctor A. C. Lawson[1] and slight additions have been made by Doctor A. P. Coleman.[2] Minor changes will undoubtedly be made in the mapping of the rocks of this region as the result of detailed work. In the work of the past season a few such alterations have been made, and these will be noted in the discussion of the rocks in the regions affected. At this place I wish to express my high appreciation of the map by Dr. Lawson. When it is remembered that at the time this map was prepared very little of the country was cleared and practically no mining development had been done, the accuracy of the work is remarkable.

The work of our party in this region was almost entirely upon the Keewatin rocks, though some outcrops of the Laurentian formation were visited. The Keewatin series as described by Lawson consists of four principal types of rock formation.

(*a*) Hydromicaceous schists[3] and nacreous schists, with some associated chloritic schists and micaceous schist and altered quartz porphyry.

(*b*) Clay slate, mica schist and quartzite with some fine grained gneiss.

(*c*) Agglomerates and other coarse clastic rocks, all more or less schistose and generally of volcanic origin.

(*d*) Hornblende schists and altered traps, with some chlorite schists of volcanic origin.[4]

Diabasic Schists

The rock series having the widest distribution in this region is the last one given, which consists principally of diabase altered in many places to hornblende and chlorite schists. Several theories have been advanced to account for the formation of these and similar schists. Lawson, in mentioning the hornblende schists, states "These are first, a very hard and tough, compact, fine grained black rock, with scarcely any

[1]Lawson, A. C., Report on the Geology of the Lake of the Woods Region, Geol. Sur. Ann. Rep., 1885, Part CC.

[2]Bur. Min., Vol. VI. (1896), Map accompanying the Report, also page 106, same report.

[3] Sericite-schists.

[4] In 1904 a committee composed of geologists from Canada and the United States visited the Lake of the Woods Region and reported as follows: (Journal of Geology, Vol. 13, p. 95.)

definite schistose structure perceptible in it. Secondly, they occur as rocks differing from the last only in having a well defined slaty or schistose structure developed in them. These are also, perhaps, a little coarser grained, and as a consequence of the schistose structure are not nearly so tough under the hammer. This slaty or evenly schistose black hornblende-rock is usually the basal formation of the Keewatin series and lies in contact with the granitoid gneisses."[5] In speaking of the diabases and diorites, the same author says:

"Intimately associated with the schistose hornblende rocks are great masses of dioritic and diabasic rocks, both schistose and massive. These rocks are for the most part interbedded with the hornblende-schists, sometimes regularly and at others in short non-continuous masses, such as might be expected as the condition of occurrence of ancient flows. For purposes of mapping, it is impossible in the wild and uncleared state of the country to separate these diorites and diabases from the hornblende-schists into which, indeed, they seem at times to merge by gradations that make any attempt at a hard boundary quite out of keeping with the natural conditions."[6]

In discussing this series of rocks as found in the Rainy lake region, Dr. Coleman differentiates the diabases and schists, and also mentions intermediate rocks known as porphyrites. He states:

The bulk of the lower basic portion of the Keewatin is formed of massive rocks, chiefly diabases, more rarely gabbros, sometimes apparently diorites. Many of them are excessively weathered, the felspars turned into an aggregate of epidote, zoisite, etc., and the augite into secondary hornblende or into chlorite and carbonates. In many cases too they have undergone shearing or crushing forces, so that all gradations may be found between massive, tolerably fresh diabase and aggregates of decomposition products that retain hardly a trace of the original structure of the rock. . . . The schistose members of the basic Keewatin are often interbedded with massive sheets of altered eruptives, and are hard to separate from the more crushed and altered ones. They consist chiefly of hornblende schists near the contact with the Laurentian, ... but in other localities of chlorite schists.

It need hardly be said that transitions between hornblende and chlorite schists are numerous. There are also paler green schists . . . largely charged with epidote and zoisite, forming links to a set of hard, compact, pale green rocks showing little or no trace of schistose structure and consisting chiefly of epidote and zoisite, usually with some quartz and chlorite. The latter may perhaps be called saussurite rocks, the result probably of the weathering of a basic feldspathic ash.[7]

The general character of these rocks is well exhibited in the railway cut at Kenora station and along the road going north from this point. This series has also been described by Dr. Lawson.[5]

"In the Lake of the Woods area one main section was made from Falcon Island to Rat Portage, with various traverses to the east and west of the line of section. The section was not altogether continuous, but a number of representatives of each formation mapped by Lawson were visited. We found Lawson's descriptions to be substantially correct. We were unable to find any belts of undoubted sedimentary slate of considerable magnitude. At one or two localities subordinate belts of slate which appeared to be ordinary sediment, and one belt of black slate which is certainly sediment, are found. In short, the materials which we could recognize as water-deposited sediments are small in volume. Many of the slaty phases of rocks seemed to be no more than the metamorphosed ellipsoidal greenstones and tuffs, but some of them may be altered felsite. However, we do not assert that larger areas may not be sedimentary in the sense of being deposited under water. Aside from the belts mapped as slate, there are great areas of what Lawson calls agglomerate. These belts, mapped as agglomerates, seem to us to be largely tuff deposits, but also include extensive areas of ellipsoidal greenstones. At a number of places, associated and interstratified with the slaty phases, are narrow bands of ferruginous and siliceous dolomite. For the most part the bands are less than a foot in thickness, and no band was seen as wide as three feet, but the aggregate thickness of a number of bands at one locality would amount to several feet.

"We could discover no structural breaks between the above formations of the Lake of the Woods. The various classes of materials—slates, agglomerate and ellipsoidal greenstones—all seem to belong together. In short, these rocks in the Lake of the Woods seem to us to constitute one series which is very largely igneous or volcanic in origin, but does, as above mentioned, contain some sediments. This series in the Lake of the Woods area is the one for which the term 'Keewatin' was first proposed for the greenstone series, Lawson giving as one reason for proposing this name the statement that there is no evidence that these rocks are equivalent with the rocks of Lake Huron described by Logan and Murray as Huronian."

[5] Lawson, A. C., Geol. Sur. Can., Ann. Rep., 1885, CC, 37.

[6] Ibid., p. 41.

[7] Coleman, A. P., Bur. Min., Vol. IV. 1894, pp. 83-87.

[8] Lawson, A. C., Geol. Sur. Can., Ann. Rep., 1885, CC, 116.

From an economic point of view the hornblende schists and altered traps are probably the most important rocks found in this region, inasmuch as nearly all the better gold mining properties are located in them or in granite near its contact with these rocks. Such mines as the Sultana, Ophir, Regina, Mikado, Olympia and others may be cited as examples of such occurrences.

Agglomerates

Closely associated with the hornblende schists and altered traps is a series of apparently fragmental rocks to which Lawson assigned the name Agglomerate.[9] These rocks are apparently of several kinds, and in some cases at least seem to have included diabase and hornblende schists in which anastomosing chlorite veins have been developed. In other cases, the rock is apparently made up of fragments of rock which usually have an angular outline and may be assumed to be breccias. In one particular case on Ptarmigan bay a well defined agglomerate was found which consisted of fragments of at least two kinds of rock. It was noted, however, that even in these fragments schistosity had developed parallel to the general direction of schistose parting of the rocks of the region. In the case just mentioned the rocks appear to be of a more acid character than the altered traps, and the general appearance of the surface produced by splitting the rock is hardly distinguishable from that of those rocks which have been called by Lawson hydromica schists, but which might possibly be better called sericite schists.

In some cases it is probable that these so-called agglomerates include areas of volcanic ash, but the writer was unable to positively identify such origin for any of the rocks which came under his observation.

Hydromica Schists

Under this heading is grouped a series of schists which includes sericite schists, nacreous or talcose schists, occasional chloritic schists and altered quartz porphyries. As a rule these rocks are light colored and split very evenly into very thin platy fragments. A study of them seems to indicate that the sericite schist results principally from the alteration of quartz porphyry, and we get a series ranging in texture from an almost unaltered quartz porphyry through the following stages:—Brecciated quartz porphyry, agglomerate schists and sericite schists. Nearly all of these phases are shown in the region around Gold Rock, but so far as noted only the last two mentioned were found in the Lake of the Woods region.

Clay Slate

The clay slates and quartzites have been described by Dr. Lawson as occurring in the Lake of the Woods and on Shoal lake, but although the writer visited two localities where these are mapped he found nothing which would be definitely called a slate. In one case, however, on the north side of Shoal lake a banded quartzitic rock was noted very similar in appearance to the rocks of the iron formation, and it is possible that these rocks should be correlated.

Granites

On both Lake of the Woods and Shoal lake are to be found extensive deposits of granite and a fine grained rock which has the same composition as granite, but is so compact in texture that the minerals which compose it cannot be distinguished with the naked eye. This fine grained rock is called felsite, but for the purposes of mapping, both this rock and the granite are included under the one heading. The granite areas most important at the present time are those on Bag bay, Shoal lake; Regina bay, Lake of the Woods; and possibly the granitoid rock at the Sultana mine which has been classed as Laurentian. The importance of these lies in the fact that gold-bearing veins have been found intersecting them. It is very probable that in the vicinity of other granitic outcrops gold veins will be found either in the granite or in the hornblende schists adjoining it.

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[9] Lawson, A. C., Geol. Sur. Can., Ann. Rep., 1885, CC. 49.

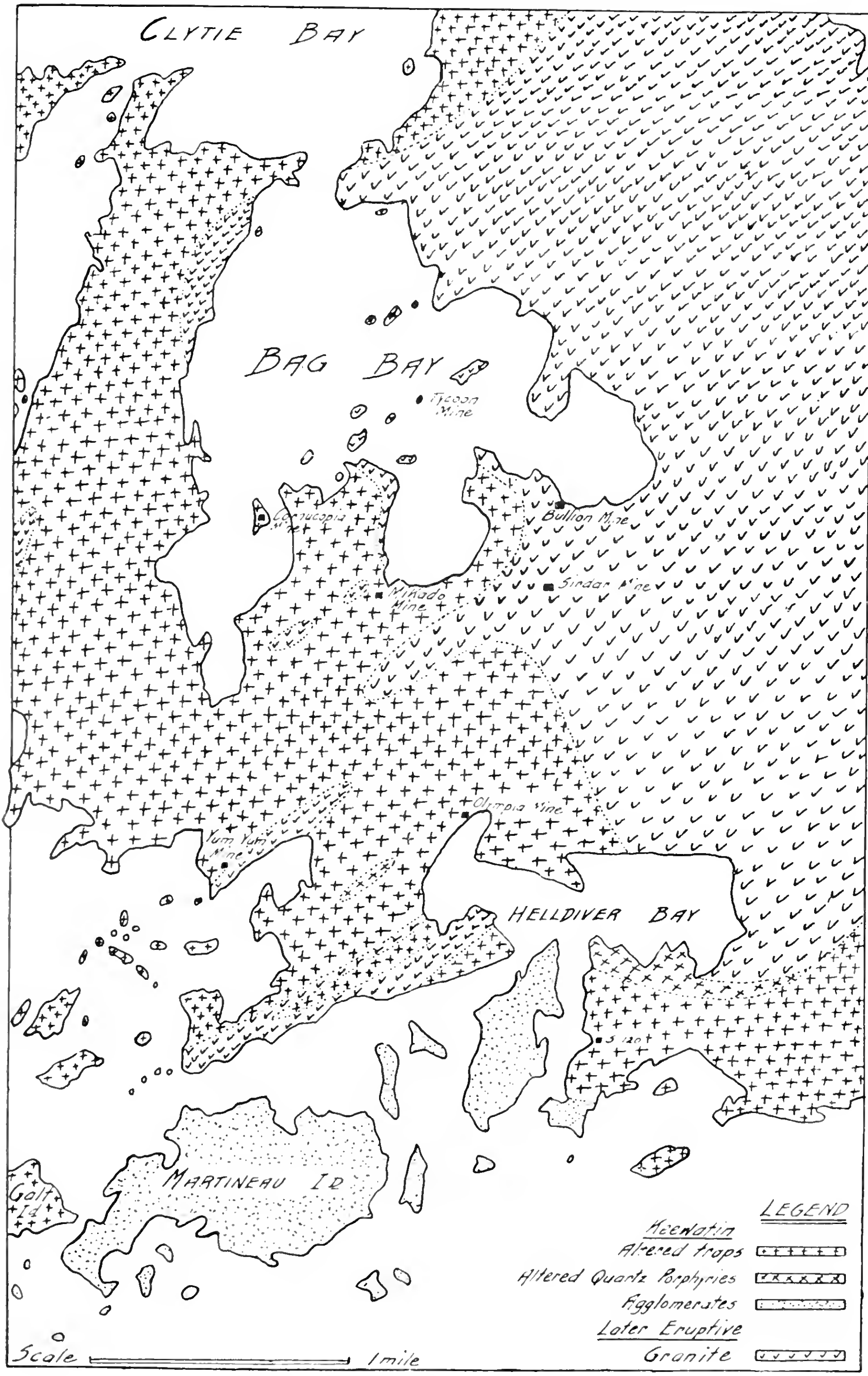


Plate No. 1. Gold mining region of Western Shoal lake.

Physical Features

The region around Lake of the Woods and Shoal lake is in general well wooded, the forest consisting principally of spruce, balsam, Norway pine, some white pine, jack pine, birch, and poplar. The country round the northern part of Lake of the Woods where rock is not present in usually covered with sand or a sandy loam. The rocks give a rugged aspect to the scenery, but although much of the rock is precipitous near the shore of the lake, the elevation of the hills will seldom be found to be more than 250 feet above the lake level, and in most cases not more than 50 to 100 feet. In general, the form of the rocks may be said to be rounded, giving what is known as *rôches moutonnées*. This appearance is undoubtedly due to glaciation, though in some cases it is difficult to comprehend how the rocks could have been affected by this agency. The lakes themselves, particularly in the northern part, have great numbers of islands, some of them several square miles in area. The presence of these islands and of rocks which come near the surface makes these lakes difficult for navigation. In general it may be said that both lakes are shallow, and in the case of Shoal lake the name indicates the fact.

Gold Area of Western Shoal Lake

Location S. 120

On the east side of the entrance to Helldiver bay is a claim upon which a two-stamp mill was about to be erected. The prospecting has been done by Mr. Andrew Johnson, and as a result of pannings and assays it was deemed advisable to put up the mill for the purpose of thoroughly proving the value of the property. We accompanied Mr. Johnson, who at the time was in charge of the Mikado property, to his claim, and by panning found a fair showing of gold in three veins.

In examining this claim and the east end of Helldiver bay it was found that the granite extends farther than is indicated on the map. Instead of stopping at the northeast corner of the bay it extends to the southeast corner; and from that point west to the mouth of the bay the rock is principally altered felsite or quartz porphyry, which develops a schistose structure. These corrections are shown on the accompanying map. See Plate No. 1.

Olympia Mine

On the northwest arm of Helldiver bay of Shoal lake is located the property known as the Olympia mine. A shaft about seventy-five feet deep has been sunk here, and a tunnel driven to intersect the shaft. At this first shaft the vein is about 3½ feet wide on the surface, but where the tunnel intersects the shaft the width is about six feet and it shows considerable variation in the shaft. The vein material is chiefly quartz, although considerable calcite is present. The walls of the vein are well defined and schistose, but a short distance away the rock is apparently unaltered diabase.

Several test pits have been sunk on this property, and a tunnel about 400 feet long has been driven along one of the veins. A fully equipped 10-stamp mill has been erected on the premises, but at the time of my visit it was idle. The mine is in charge of Mr. J. Hubner.

Yum Yum Property

The Yum Yum mine is located on the shore of Shoal lake, about a mile and a half west from the Olympia mine. At the shaft the rock is diabase, but at the old camp it is a fine grained felsite similar to the felsite at the Mikado shaft. The diabase at the shaft has developed schistosity parallel to the vein, which is about two feet wide on the surface, but pinches out about 15 feet below the surface. Considerable work was done here and the dump would indicate that the shaft had been sunk from 150 to 200 feet. Near the shaft an open cut was driven along the vein, but the work seems to have been thrown away as the vein pinched out. At several places in the woods to the southwest we were shown outcrops of a vein which appears to be a continuation of the one exposed in the open cut.

Fig. 1.—Olympia Mine.

Fig. 2.—Diabase with granite intrusions.

Mikado Mine

This mine is located on the south shore of Bag bay, Shoal lake, about 45 miles from Kenora by the steamboat route, but about 35 miles by the winter route. The geological features of the country immediately about the mine are indicated on the map accompanying this report (See plate No. 1). At the mouth of the shaft is an outcrop of felsite and granite which have been intruded in trap rock. This trap has to a large extent been altered so as to form hornblende and chlorite schists. The vein cuts across the granite and extends into the trap on both sides of the granite intrusion, so that it may be looked upon as a fissure vein. The vein consists of quartz which in places is divded into bands by thin seams of chlorite, sericite or talc. On the first visit to the mine in May, the writer examined the first three levels and found that the vein averages about four feet wide. Associated with the quartz in the vein, the following minerals are found in greater or less abundance; pyrite, chalcopyrite, bismuthinite, molybdenite, and malachite. In addition to these, free gold is found and at times the specimens are extremely rich. Near the north end of the third level the writer found specimens which showed free gold.

It is estimated that about five hundred thousand dollars' worth of gold has been taken from the Mikado, but it is said much ore of high grade was stolen and for this and other reasons it is impossible to form a correct estimate of the production. This mine, however, was one of the three or four principal producing mines of the Lake of the Woods region in the late nineties. The discovery was made about 1893 by an Indian who brought samples to Mr. Chas. Bunn, manager of the Hudson's Bay Company's store at Kenora. The specimens were so promising that Mr. Bunn and Dr. S. S. Scovil, of Kenora, took up the location and had mining work started. Later they sold the mine to Col. Engledue of London, England, and his associates, and mining operations were carried on for several years until, in 1903, the property was shut down indefinitely.

During the past year Mr. H. A. C. Machin, M.P.P., has had the mine pumped out to the fourth level and an examination made by R. B. Nickerson, M.E., who made assays of the ore in the first four levels, from the dumps and from the pile of tailings. The result of this examination was such that a company called the Kenora Mines, Limited, was formed to take over the property, and work was started in July with Mr. Nickerson as general manager.

Preparatory to regular mining operations, the plant has been remodelled, and at the time of our second visit in the latter part of August most of this work was completed, except the installation of the new cyanide plant. The foundations for this plant were being installed but the equipment had not yet arrived. The shaft house has been remodelled so that the ore, as it is dumped from the skip, passes over a grizzly into a large Blake crusher, which reduces the rock to fragments about two inches in diameter, and passes immediately by gravity with the fine material separated by the grizzly into a smaller Blake crusher which reduces it to less than an inch in diameter. The ore is then conveyed by tram cars to the stamps.

The mill is equipped with 20 stamps with amalgamation plates. It is proposed to treat the tailings by cyanidation.

The power for the plant is generated in two 125-h.p. tubular boilers which run the engines and air compressor. There are two Waterous engines for the crusher and mill respectively. The air compressor is made by the Rand Drill Company and has a capacity of eight drills. There are also two hoisting engines, one of them a double drum Beatty hoist for the vertical shaft, the other a single drum Lidgerwood hoist for the inclined shaft. The plant and the manager's house are lighted by electricity which is generated by a dynamo having a capacity of 125 lamps. The power for the dynamo is furnished by a 6 by 6-inch dynamo engine.

During the summer new foundations were put under the engines and compressor and a cement floor was put in the boiler house. The buildings, aside from the mill and shaft house, consist of an office, a well equipped assay laboratory, a boarding house capable of housing 100 men, several small houses for married men with their families, and a seven-roomed cottage for the manager. On my second visit I was shown

a gold brick valued at about $1,200, which the manager, Mr. Nickerson, stated had been made from the materials obtained in cleaning up the mill preparatory to making alterations.

The work at the Mikado mine has been done upon three veins. On number one vein the inclined shaft has been sunk to a depth of 540 feet, and nine levels have been opened up. On the occasion of my first visit the first three levels were inspected, but as the other levels were filled with water it was impossible to go lower. On the second visit the fourth level had been pumped out and an examination was made of the vein and accompanying rocks. In width the vein does not vary greatly, averaging from four to five feet. The vein material is largely white or pale bluish white quartz, with which are associated thin bands of darker quartz and dark chlorite and other micaceous material which on account of its ready cleavage permits of easy mining.

In addition to No. 1 vein from which most of the gold was obtained there is about 500 feet east a vein lying in the granite belt, which is known as No. 2 vein. A shaft was sunk on this to a depth of 250 feet, and three levels were opened, upon which about 850 feet of drifting was done. Work upon this shaft, however, was discontinued.

About fifteen hundred feet south of the main shaft is No. 3 vein which cuts the altered diabase. An 80-foot shaft has been sunk in this vein, and two diamond drill holes put down which showed that it continued to a depth of five hundred feet. It is stated that the average assay values in the shaft and that part of the vein cut by the diamond drill were about $4.00 per ton.

Tycoon Location

The Tycoon mine on location D 219 has been sunk in granite which for the most part is gray, though in some parts it has a red or flesh color. As a building-stone this granite is an ideal material. The shaft measures 8 feet 6 inches by 5 feet 6 inches, but is filled with water, so that little if anything could be seen of the rock in which it is sunk. A search on the dump showed little if any vein matter, though a little pyrite and some siderite altering to hematite were found. Apparently the mine was sunk with a view to intersecting the Mikado vein, which if produced should come near the island. The equipment has been removed and the mine is abandoned.

Sirdar

Directly north of the Bullion mine on the shore of Bag bay is the shaft of the Sirdar location which is sunk in granite and felsite. The mine is abandoned, and a search of the dump failed to show vein material, although some pyrite and chalcopyrite were seen. It is stated that this shaft was sunk 125 feet and a tunnel driven about 200 feet towards the Mikado claim. The surface conditions are similar to those at the Tycoon mine, and give evidence that the shaft was sunk without competent advice.

Bullion

This property is located east of the Mikado, and the shaft is at the contact of granite and dark altered diabase locally known as slate. The ore here is of interest because it contains molybdenite as well as the other minerals which occur at the Mikado, but most of the specimens on the dump were not highly mineralized.

A test pit in a vein on the Bullion property shows considerable molybdenite and a little free gold, but for some reason no further development was done on this pit and the shaft has been abandoned.

Cornucopia

This property is in Bag bay about a mile west of the Mikado mine on an island known as mining location D 212. The location has been abandoned, and the shaft is filled with water, but the property is of interest inasmuch as the vein contains a considerable quantity of pyrrhotite, apparently, however, unaccompanied by nickel in commercial proportions.

Cameron Island Mine

The Cameron Island mine is situated on an island a little north of the centre of Shoal lake. At the time of our visit the mine was not in operation, but a few weeks previously it had been pumped out with the intention of resuming work. The rock on the island is altered trap, which in some cases contains very little feldspar and might be looked upon as pyroxenite or in some cases as amphibolite. One or two small out-crops of felsite were noticed which are apparently intrusions in the trap. There are in all seven veins on the island, with a general strike of about N. 45° E. On the east side of the island a tunnel has been driven about sixty feet, cutting two of these veins. About the centre of the island a shaft has been sunk 133 feet, and two levels have been opened up, with about 50 feet of drifting on the first level, and 220 feet

Fig. 3.—Contact near Indian Joe mine of hydromica schist and chlorite schist.

on the second. In the second level the main vein averages about four feet in width, the hanging wall is well marked, but the foot wall is not distinct, though there is a well-mineralized contact zone. The vein material is quartz, with schistose bands which consist largely of chlorite. The metallic minerals present are pyrite, pyrrhotite and chalcopyrite. Cross-cuts have been driven on both sides of this vein into the diabase, and in each case a vein has been encountered parallel with the principal vein. On going round the south side of the island it was possible to identify all the veins by the rusty character of the out-crop. It may be said that the principal sulphide in the ore is pyrrhotite, which in its alteration gives a purplish red rusty out-crop. The equipment at this mine consists of one 80-h.p. boiler, one 25-h.p. boiler, one feed water

pump, one mine pump, one 50-h.p. Corliss engine, one 15-h.p. hoisting engine, one Blake crusher, two 5-stamp mills, and two Frue vanners. The mill is in good condition and the machinery well taken care of. The capacity of the mill is about 20 tons per day.

Indian Joe

This property is located on the north shore of Shoal lake near the entrance to Clytie bay. The shaft is sunk in the hydromica schists a short distance from the shore, and at the time of my visit was nearly filled with water, so that the only way of getting any idea of the property was by an examination of the dump. The rock found

Fig. 1—Pseudo-fold, granite in schist, Carl Bay.

consists principally of sericite schists with bands containing siderite and pyrite. Much of the material exposed on the dump had been weathered so that the iron minerals had been changed to limonite, and in many cases, even though no iron minerals were noticed on a fresh fracture, a certain amount of limonite had been formed, so that the rock as a whole resembles in many respects banded iron formation. The ore from this mine consists chiefly of quartz carrying sericite and pyrite, but the vein apparently is narrow, as the chief material to be seen is schist. At this place there are two kinds of schists, one light gray, the other dark greenish-gray to nearly black. The contact between these two is well shown near the old landing, and is an irregular line which crosses the planes of schistosity. (See fig. 3.)

Mining Location M.H. 7

At location M.H. 7, near the mouth of Carl bay, on the south side of Shoal lake, a vein consisting almost entirely of pyrrhotite is found outcropping on the shore of the lake. The vein is about 12 feet wide and is between walls of altered trap. On the surface the pyrrhotite has been oxidized, so that sulphate of iron had been formed in places that were protected from the direct washing of the rain. In other places the oxides of iron had been formed, but the general color of the oxides is purplish red. This seems to be the color most commonly developed in the oxidation of pyrrhotite, so that it may be looked upon as a good indication of the presence of this mineral by a prospector. So far as seen, no work of any account had been done on this claim. The existence of the body of pyrrhotite in the altered trap near its contact with the so-called hydromica schists suggests the possibility that part at least of these rocks may possibly be referred to the iron formation. This supposition is further strength-

Fig. 5. Contact of granite and altered trap, Portage Bay.

ened by a brief examination of the pyrrhotite deposits on West Hawk lake near Ingolf.

At the east end of Carl bay a pyrrhotite vein was found about four feet wide near the contact of the granite and altered trap. A small test-pit had been sunk, but work has been discontinued.

A trip was made across Dead Man portage into Portage bay of Lake of the Woods, where on an island near the centre of the bay it was found that at the shore the greater part of the rock is granite which is overlain by altered trap.

On the northeast side of Carl bay, near the contact of the granite and so-called hydromica schists, a peculiar intrusion of granite in schist was found. This is directly at the water's edge and forms a pseudo-fold. (See fig. 4.)

The darker rock shown in the picture is schist with vertical foliation. This has been intruded by granite, which has broken across the foliation and penetrated between the laminae. Although the schist shows foliation in every part, no trace of foliated texture could be seen in the granite. Going west from this point in Carl bay, it is

found that on the east and south side of McP. 37 granite underlies and penetrates the Keewatin rock in much the same way as on the island in Portage bay.

Sultana Mine

The Sultana mine is located on Sultana island, in Bald Indian bay, about seven miles from Kenora, but the maps show this island as being part of the mainland. The mine is located very near the contact of altered trap and a granite rock, which in the hand specimen and even in its field relations can scarcely be distinguished from some of the granite on Portage bay south of Dead Man portage between Shoal lake and Lake of the Woods. This rock, however, has been mapped as a Laurentian outcrop. The altered diabase at this point can hardly be distinguished from that found at the Mikado mine on Shoal lake.

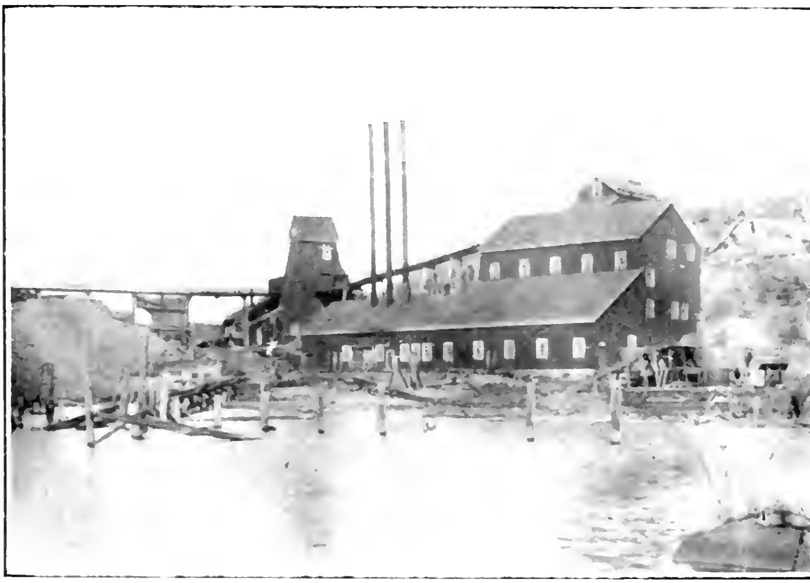


Fig. 6. Sultana mine and mill.

The shaft of this mine was completely filled with water, and no mining has been done for several years. There is, however, a short distance to the west of the shaft, an open cut from which considerable ore was taken when the mine was in operation. The vein in this cut is from four to six feet wide, and consists chiefly of quartz. It is of interest to note that this vein makes a turn at an angle of about ninety degrees. The wall rock of this vein is granite, but in the shaft of the Sultana both granite and trap are found, and the vein is said to cross their contact. An examination of the dump shows that the greater part of the rock is trap. Dr. Coleman, who had an opportunity of examining the mine when it was in operation, states that the veins of the Sultana are bedded veins[10] with a nearly vertical dip in chlorite and hornblende schists of Keewatin age. In addition to native gold it is reported that considerable molybdenite was found in this mine, and the tailings along the shore show that there was a large quantity of pyrite and other sulphides in the vein.

A short distance to the east of the Sultana is the old Pashaw shaft, which is sunk in altered diabase on a vein very heavily impregnated with pyrrhotite and resembling in mineral composition and association the material found at Cameron island. The

[10] Coleman, A. P., Gold in Ontario, Bur. Min., Vol. IV. (1894), p. 68.

patent for the Sultana location was issued in 1888 by the Indian Department, but prospecting was not commenced until 1890, and actual mining operations began in March, 1892."[11]

During the time this mine was in operation it is estimated that about one million dollars' worth of gold was extracted, and it was undoubtedly the producer of a larger amount of gold than any other mine in this locality, and possibly in all Ontario.

At the present time, although the shaft is full of water, the mill equipment is in excellent repair, and apparently in condition to resume work on short notice. The affairs of the company are in litigation, and the mine and equipment are under the care of Mr. Richards. This mine is the deepest of any in the Lake of the Woods region, and it is stated that the shaft reaches a depth of 600 feet.

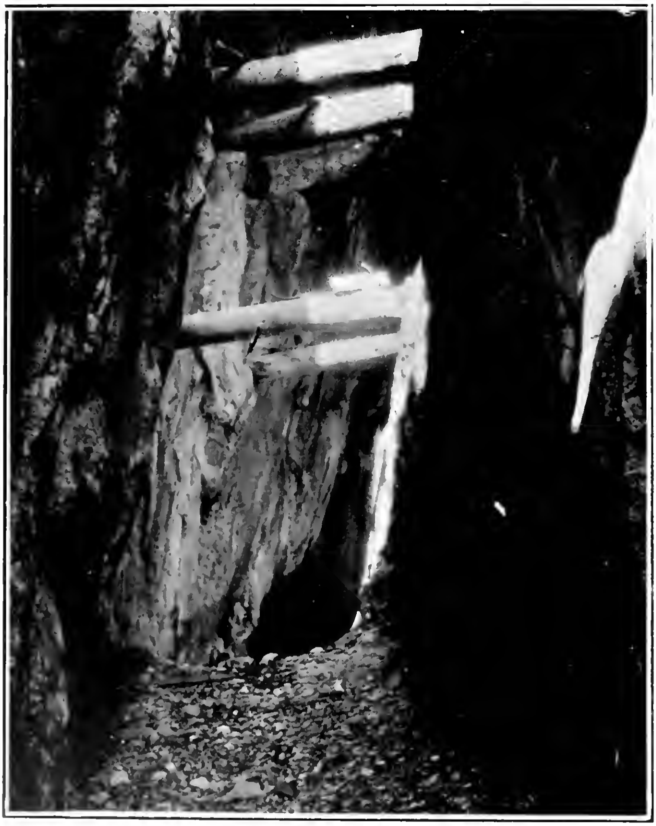


Fig. 7.—Sultana mine, open cut.

There are several veins on and near the Sultana property that have not been worked to any extent.

The mill equipment is as follows: one 100-h.p. Corliss engine, three boilers, 145 h.-p., one 10-drill Rand air compressor 12 by 18, one 8-h.p. dynamo engine and one dynamo, one hoisting engine 48 x 60, one gyratory crusher, 30 stamps, 6 Frue vanners, one clean-up pan, one lathe, one drill, 1 shaper. From an economic point of view it would seem that a mill such as has been built at the Sultana mine should be kept running, not only on the product of this mine, but upon the product of adjoining properties, either purchasing the ore at a value based upon the assay and cost of extraction, or treating the

[11] Blue, A., Gold Fields of Ontario, Bur. Min., Vol. III. (1893), pp. 15-19.

ore at a fixed rate per ton. Several mines in the vicinity might easily be worked in this way with greater chances for profit than could be expected if a small stamp mill is erected for every hole sunk in the region.

Ophir Mine

The Ophir mine is located on the west side of Sultana island, facing Quarry island. It is almost at the contact of the altered trap and the Laurentian granite. On the surface the vein is about four feet wide, but, on going down, increases in width, so that at a depth of about twenty-five feet it reaches a width of about six feet. The vein matter is principally quartz of a bluish white color, which is frequently sprinkled with particles of gold visible to the naked eye. On our first visit to the Ophir mine the shaft was full of water, but on visiting it again in the latter part of August we found that Mr. Richards, who also has charge of the Sultana mine, had during the summer pumped out the mine and was preparing to begin mining operations. It is to be hoped that this mine may have a fair working trial, as the quartz that is taken

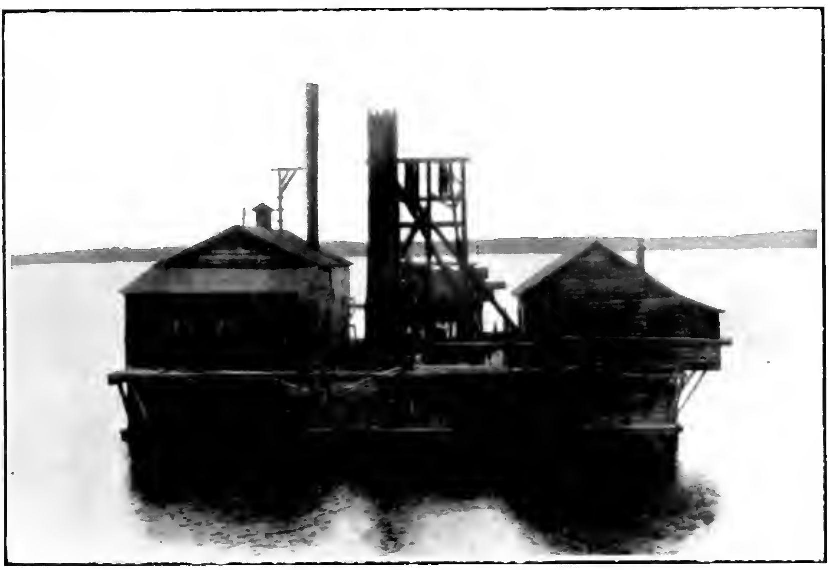


Fig. 8.—Burley's shaft.

from the mine is apparently a rich ore, and all who have mentioned this mine in their reports seem to agree that it is an exceptionally promising prospect. At the present time, although it is called a mine, it can be considered only as a prospect upon which the assessment work has been well done by clearing a large part of the vein, and sinking the shaft so as to show the continuance of the ore body to a depth of about a hundred feet.

Burley's Shaft

Directly opposite the open cut of the Sultana mine is a peculiar structure known as Burley's crib, which was erected on an island about a half-mile from its present site about 1897, and towed by steamer to this point. It was sunk by loading with rock so as to rest on clay which had been put on the bottom of the bay. A shaft was put down to intersect the extension of the Sultana vein under the lake. It is reported[12] that diamond drilling had shown an extension of the Sultana vein which was thick

[12] Bur. Min., Vol. VII. (1898), p. 115.

enough and rich enough to warrant this expenditure. Further progress in the development of this mine and plans of the crib and shaft have been given in detail by Mr. Bow.[13] The mine was idle from June, 1899, to the summer of 1903, when it is reported[14] that the shaft was pumped out preparatory to carrying on further development, but no report of such development was ever made, and the mine is now idle.

Locations on Big Stone Bay

Formerly on Big Stone bay several mines were sunk, among which may be mentioned the Keewatin, the George Heenan, the Winnipeg Consolidated, Black Jack, Gold Hill, and Golden Gate. On Blindfold lake, which may be considered as a part of this same district, was located the Black Jack mine.

Of these mines the first three and the last were visited by the writer, but all the buildings are practically in ruins, all equipment has been removed, the shafts are filled with water, and little trace of the veins could be found. The vein of the Winnipeg Consolidated mine was seen in the shaft, and at a depth of six feet it has a thickness of about three feet and is between walls of altered diabase.

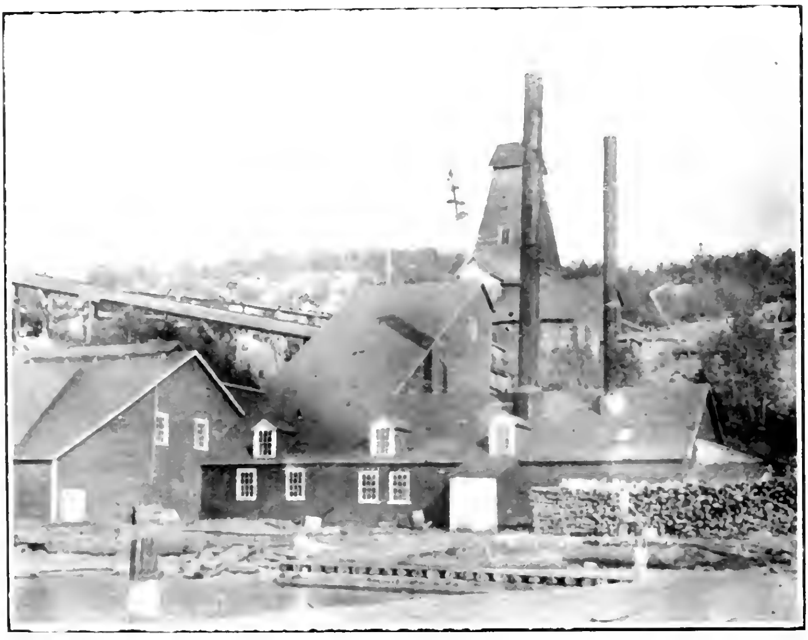


Fig. 9. Regina mine.

At the Black Jack mine, on Blindfold lake, the vein, which shows in the shaft, is from five to six feet wide. The vein material on the dump consists almost entirely of quartz, and is similar in appearance to the quartz at the Ophir mine, but not so blue. The country rock is granite and gneiss of Laurentian age.

At the George Heenan location the camp was in ruins, and although a small test pit was found, the shaft could not be located.

At the Keewatin mine most of the buildings have been burned; the shaft house, however, still remains, but has been stripped of its machinery. The rock on the dump consists of altered diabase and hornblende schist, with some pyrite. Around the ruins of an old building was piled considerable quartz which contains a good percentage of pyrite, and if this represents the vein material it gives fair promise.

[13] Bow, J. A., Bur. Min., Vol. VIII, (1899), pp. 52-54 and 64.
[14] Carter, W. E. H., Bur. Min., Vol. XII, (1903), p. 60.

Regina Mine

The Regina mine, which is also known as the Black Eagle, is located on the south shore of Regina or Lobstick bay of Lake of the Woods. Upon this property are eight distinct veins varying in width from a few inches to 12 or 15 feet. The main shaft is sunk on No. 3 vein, and although the mine is not working at present, the water has been kept below the fourth level. The buildings and equipment of the mill are in excellent condition, and work could be resumed with very little delay. The vein upon which the shaft is sunk varies in width from about 2 feet to 6 feet with a general average, so far as seen by the writer, of about 4 feet, and at only one place was a width of less than two feet noted. The vein cuts the contact of granite and a more or less altered trap, and in this respect is like the Mikado and Sultana mines, which, with the Regina, have furnished most of the gold obtained in this region. The shaft has been sunk to a depth of 515 feet, and nine levels have been opened up at intervals

Fig. 10. Regina mill.

of 60 feet. Although the vein as seen in the upper four levels averages about four feet in width, it is said that it increases in the lower levels to a width of eight to twelve feet. The shaft follows the dip of the vein, so that there are some objectionable curves in it, and hitherto all the hoisting has been done by bucket. The vein is principally quartz, though in places a fair percentage of a rusty carbonate is found intermingled with the quartz. Apparently there is a good quantity of ore in sight for conservative mining, and a study of the plan of the workings seen at the mine would indicate that the pay chute has not been entirely worked out. This mine is credited with a production of about five hundred thousand dollars, but apparently it was worked at a loss.

The West vein, which is about 20 feet wide, consists of two parts, that upon the north being quartz interbanded with rusty carbonate, while the southern portion consists almost entirely of this rusty carbonate.[15] A shaft has been sunk about 70 feet. This vein is in the trap, and its extension into the granite has not been found. No. 1

[15] A carbonate vein of similar dimensions at Porcupine, in northeastern Ontario, may be compared to this deposit. It is known as the West Dome, or Foster.

Plate No. 2.—Whitefish and Regina bays.

vein consists of quartz, and is in the granite a short distance east of the west vein, near the dwelling houses, and is from 6 to 8 inches wide. No. 2 vein varies in width from a trace to a foot, and is near No 1 vein and has the same sort of wall rock, but no opening has been made either upon No. 1 or 2 veins. No. 4 vein is to be seen just back of the manager's house. It is about a foot wide and has been exposed for about 150 feet. No. 5 vein is small, and so far as seen does not exceed 3 or 4 inches in width, and no opening has been made upon it. Nos. 6 and 7 veins come together, giving a total width of about 3 feet at their junction. Both veins are quartz of granular texture in a country rock of altered diabase. A tunnel has been driven on No. 6 vein and shows it to be about 7 inches wide at the lake level.

The mill equipment is as follows: 30 stamps (gravity), 10 Tremaine steam stamps (formerly 14), 4 Wilfley tables, 1 Gates gyratory crusher, 1 belt conveyor from crushing house to mill, 1 clean-up pan, two 80-h.p. and one 50-h.p. boilers, 1 hoist (12 x 12 inch cylinders), 1 crusher engine, 1 Corliss engine, 1 compound air compressor, 3 mine pumps, 1 feed-water pump, 6 air drills, 1 lathe, 1 drill, 1 planer, 1 upright engine, 1 dynamo, 1 engine for the dynamo.

Alterations in Geological Mapping

Minor changes were made in the geological mapping on Whitefish and Regina bays. On coming south through the Passage from Long bay to Whitefish bay, we continued west and found that the large island north of Smith island, together with the main land between this point and the Passage, consists of altered trap of Keewatin age. On going to the small bay behind this island Laurentian rock was found outcropping. In the small bay just south of the narrows (Sioux narrows) between Whitefish bay and Regina bay a granite outcrop has been mapped, but its extent is not so great as heretofore indicated. The probable extent is shown on the map accompanying (See plate No. 2). Another change, too small to indicate on a map of such a scale, should be made on the north shore of Regina bay, where a small intrusion of granite should be mapped as coming between the altered traps and altered quartz porphyries or hydromica schists.

Scramble Mine

A visit to the Scramble mine northeast of Kenora proved of interest from a geological point of view. The mine is sunk in a vein which consists largely of chloritic material interbanded with quartz, with a considerable amount of pyrite. The samples of vein material seen upon the dump have a marked resemblance to some of the leaner phases of the iron formation, but, although it is the opinion of the writer that several of the so-called veins may have the same origin as some of the bands of this formation, at the present time such correlation cannot be made. So far as was observed, no carbonate bands exist in the vein, but as the only material upon which judgment could be based is the waste rock and vein material on the dump, it cannot be positively stated that these are not present. The absence of these materials would serve to differentiate this vein from other veins in the region. The country rock is altered diabase, which exhibits a pillow structure in places. A mill-run was made several years ago on ore from this mine at the School of Practical Science, but the writer has been unable to get the result. The mine was idle at the time of my visit.

Allie Island Copper Deposits

On June 5th, having received supplementary instructions to examine the reported discovery of copper on Allie island, Lake of the Woods, I visited the claims on this island which have been taken up by F. W. Moore. These copper locations are on the south side of the island and are in a decomposed rock which consists principally of chlorite or serpentine. On exposure to the air this rock slacks like lime or marl, and resembles the serpentine from Hoboken, New Jersey, and the decomposed serpentine from Lancaster county, Pennsylvania. On first examining this rock no trace of copper was to be seen, but on crushing and panning the crushed material, small pellets, and crystals

of copper were obtained. The crystals which are found are invariably octahedral in form, and vary in size from mere grains up to one-fourth of an inch in diameter. The chloritic rock in which the copper occurs is apparently the result of the decomposition of a diabase with which it is in contact, and some specimens when broken open exhibit a nucleus of comparatively fresh diabase with an outer zone of the chloritic rock. A search was made for sulphides in the diabase but without success, although a few small specks too minute to be indentified in the field were found, which resemble pyrrhotite.

Four claims had been staked out, and two shafts about twenty feet deep had been sunk. The amount of copper found in the rock up to that time was apparently not sufficient to be of economic value. A second visit was made on September 1st. During the summer a new shaft about forty feet deep had been sunk near the more promising of the earlier shafts, and at this depth the rock was still soft and chloritic. On going down into the shaft a considerable improvement was noted in the character of the ore. The mine is just west of French Narrows, about 14 miles from Kenora. In case this property proves of economic value there should be a further development in copper mining on Lake of the Woods, as the same type of rock having similar geological relations is found on the west side of the large island between Queen and Middle islands.

Carbonaceous Schists

A visit was made to the west side of Corkscrew island in Ptarmigan bay for the purpose of examining some small deposits of carbonaceous schists. These schists are found in narrow bands near the contact of the hydromica schists and the altered diabase. They consist principally of thin films of graphitic material between layers of the hydromica schist. The best development of this graphitic material is in a contorted band or vein between parallel beds of schist, which shows considerable variation in texture and ranges in color from grayish green to nearly black. From an economic point of view, this material is valueless, but it is mentioned here because several deposits of this sort are found in the Lake of the Woods region, and samples have been shown to the writer which come from regions round Port Arthur and Duluth, Minn. In nearly every case investigations have been made to show the value of such material as coal deposits, but so far as they have been investigated they have proven absolutely without value.

Molybdenite

The existence of the molybdenite in the Lake of the Woods region has been noted by Lawson,[16] who mentions an occurrence of this mineral in veinules traversing granitoid gneiss on Quarry island near the Sultana mine. A visit to Quarry island was made, but unfortunately the veins carrying molybdenite could not be found. It is also reported that molybdenite was found in the ore at the Sultana mine.

On examining the Mikado mine, the writer found small particles of molybdenite disseminated in many parts of the vein.

On mining location D 149 in Lag bay of Shoal lake, about a half mile from the Mikado mine, is a vein in grey granite, below the lake during high water. The vein is about a foot wide and consists principally of quartz in which scales of molybdenite nearly half an inch in diameter are scattered rather abundantly. Much of the molybdenite is oxidized so as to form the yellow oxide of molybdenum, molybdite. The vein at this place is mostly under water and in all probability not more than 20 feet could be exposed above water.

Building Stone

On Lake of the Woods and Shoal lake are several localities where good building stone may be obtained for local use. The rock most favorable for this purpose is granite, and suitable material may be obtained on Quarry island about seven miles southeast of Kenora. This rock has been quarried some time in the past, and it is stated that when

[16] Geol. Sur. Can., 1885, CC 141

Fig. 11. Diabase cliff, Crow lake.

Fig. 12. Crow (Kakagi) lake.

the Canadian Pacific railway was being built the stone for several bridge abutments was obtained here. The granite is moderately coarse grained but would dress nicely, and makes an excellent material for building and monumental purposes.

East of the Mikado mine on Shoal lake is a large granite area, which also outcrops on Echo bay of Lake of the Woods. On the Shoal lake side the granite is usually gray in color, though occasionally flesh colored granite is seen, and this is also an excellent building material.

At Hawk lake station a quarry has been opened up in Laurentian granite. The stone is an attractive one for building purposes, and has been used in the construction of the new court house at Kenora. Much of the rock is shipped to Winnipeg, and finds favor with the builders of that city.

Many other good granite exposures are to be seen on Lake of the Woods, but those mentioned are probably the most desirable for building purposes. The distance from railway transportation is a bar to the development of these deposits for anything but local use.

The large deposits of trap rock in this vicinity furnish a material which is hard and tough, but not desirable as a building stone because of its liability to disintegration. This material, however, makes ideal road metal, and should be used to a greater extent in making roads in this region.

Lake Manitou Area

The rock in the area covered by our map (Plate No. 3), is principally diabase, altered diabase and porphyrite. West of Mud lake nearly all the rock is schistose and has a general strike of N. 30° E. to N. 45° E. About the centre of this portion is a band of altered quartz porphyry (so-called), varying in texture from an almost unaltered rock, having approximately the composition of andesite, and which on being crushed is converted first into agglomerate breccia, and finally into sericite schist. Between this formation and Mud lake the rock varies considerably in texture, in some cases being nearly unaltered diabase, grading on the one hand into porphyritic diabase and on the other hand into a rock showing large lens-like markings—pillow structure. All these rocks have undergone alteration to a greater or less extent and have been converted into schists. Near Mud lake is a band of sericite schist, which passes through the properties of the Paymaster and Detola mining companies, crosses the lake and skirts the east shore of the north end of the lake. East of Mud lake the rock is almost entirely diabase, which in the southeast corner of the map is hardly altered, but nearer Mud lake shows considerable schistosity. Upon the map some of the principal veins are indicated, but an inspection shows that a large number of them consist of a light colored schist, containing quartz and a considerable percentage of pyrite. In general, these veins have the same strike as the schists in the region, and it is the writer's opinion that they have been formed by movement of the igneous rocks, which resulted in slaty cleavage being developed, and that the gold values and quartz have been deposited by secondary enrichment. As a rule these veins contain a fair percentage of chlorite and possibly talc, and it would appear that they are largely the result of the alteration of basic igneous rocks. In a few cases veins are to be seen which are largely composed of pure quartz, which shows little if any banding. Such veins are found on claims G. 27, H.P. 301, and on H.P. 371, near the office of the Laurentian mine. On the road leading from the Little Master mine to the government road is a pyrite vein on claim S. 29, which apparently lies in about the same band as the Jubilee and Laurentian veins. Most of the other veins in this neighborhood are of the schistose type, and so far as the writer could judge this is the character of the Laurentian, Paymaster and Detola veins.

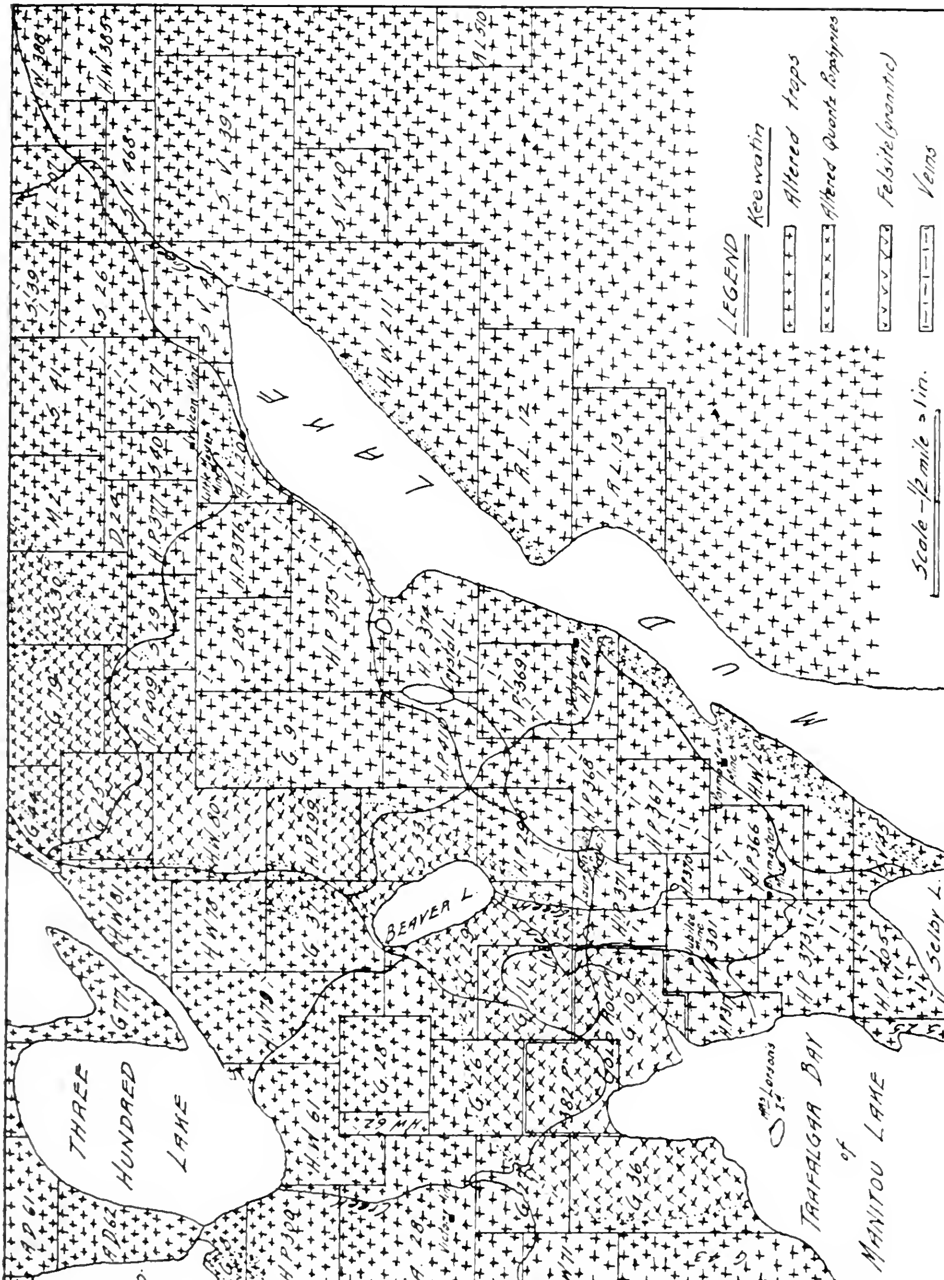


Plate No. 3.—Gold Mining area of Gold Rock and vicinity.

The map of the Manitou region, issued by the Geological Survey of Canada, indicates the formation in the neighborhood of Gold Rock as agglomerate. Near the landing the rock has a mottled appearance (see fig. 16), and might with propriety be classed as such. An examination of these rocks, however, shows that they grade on going westward on G. 36 into a so-called quartz porphyry, and the microscope indicates these mottled rocks to be breccias developing a schistose structure, and derived from the type of the rock found just to the west.

If all fragmental rocks in this region are to be classed as agglomerate, the determination of Mr. McInnes is correct, but as this is evidently derived by brecciation from an igneous rock, it is probably better to remove it from the somewhat doubtful classification. The extent of this formation along the shore of the lake is not so great as was supposed by Mr. McInnes, as its contact with the altered trap on Manitou lake comes within the limits of our map.

Fig. 13. Gold Rock, Upper Manitou lake.

East of this body of altered quartz porphyry the rocks have previously been mapped as altered quartz porphyries, and it is probable that this determination was made as the result of the examination of outcrops on some prominent points along the shores of Mud lake. As will be seen from the map (see Plate No. 3), there is a band of altered quartz porphyry or sericite schist, which extends from Selby lake through the Paymaster and Detola properties, and after crossing Mud lake skirts the east shore of the north end of the lake. The actual width of this rock is somewhat exaggerated on the map, particularly on the east side of the lake, where it is found as a narrow band at three points along the shore. Between this body of sericite schist and the larger body of similar rock at Gold Rock altered diabase and porphyrites are the only rocks found by the writer.

To the east of Mud lake the rock within the limits of the map is nearly all basic igneous rock, which is more or less altered. For the most part the rock is dark, but there are a few bands of light colored porphyritic diabase, which in some cases have developed schistosity and have a slight resemblance to the altered quartz porphyries. In going east from Mud lake to Mountain lake the rock is entirely diabase, which shows less alteration than most of the similar rock in the region.

Fig. 14. Diabase showing pillow structure.

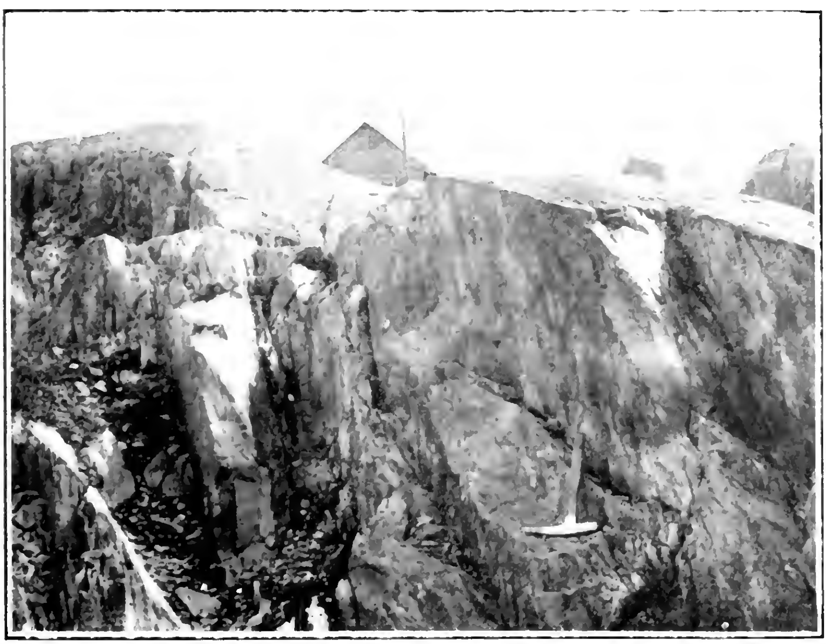


Fig. 15.—Altered quartz porphyry, Gold Rock landing.

A few outcrops of granite or felsite were found near the outlet of Peekaboo lake and on H.W. 28, and an examination outside of the limits of the map showed that isolated outcrops are found along the extension of the line joining these areas, and may possibly be assumed to be outlying exposures of a granite area, some two or three miles southwest of this point.

A marked variation in the compass was found in two places near Gold Rock. On the bluff overlooking Manitou lake at the north end of H.P. 317 the compass needle was deflected about 45° and the dip needle was deflected 66°. This probably indicates the presence of a body of magnetite in the trap, but it is not a large body, as the variation was found only in an area not more than one hundred feet in diameter. A similar magnetic variation was noticed on the diabase east of Mud lake, but this is likewise a limited area.

Victory Mine

The Victory mine is located on claim McA. 28 about midway between the village of Gold Rock and Peekaboo lake. The country rock here is diabase, with possibly some diabase agglomerate. At the mouth of the shaft is a light gray schist, and from the appearance of the material on the dump it would seem that this schist contains a notable percentage of carbonate of iron, which on exposure to the atmosphere is converted into limonite. Interbanded with this schist are bands of quartz which give an appearance to the vein material similar to specimens found in the iron formation. This schistose structure is quite characteristic of the veins found in this region, inasmuch as a large number of the mines have been sunk in such material. Frequently these veins show large bands of quartz, which have probably been formed by crystallization from a solution coming through the crevices in the rock, though it is by no means certain that the whole vein may not be the result of alteration of the wall rock with the removal of a large percentage of the iron and other bases by solution, and a separation of silica as quartz. The shaft of the Victory, which is 100 feet deep, is filled with water, consequently no examination of the underground working could be made. Through the window of the boiler-house could be seen two boilers, a hoisting engine, and an air compressor, so that the mine is equipped for work, but not for milling. A short distance from the mine are the office and several dwelling-houses, which are in good condition.

Laurentian Mine

On location H.P. 371 is located the Laurentian mine, which has produced most of the gold taken out from the Manitou district. Four veins were seen by the writer on this property, but the one upon which the shaft has been sunk is probably the largest. The ore body consists of bands of quartz varying from a mere trace up to several inches in width. On the second level of the mine a cross-cut has been driven towards the west, and it is there seen that at the margin of the vein is a brecciated wall rock which grades into a porphyritic diabase. At a distance of less than 40 feet from the vein this porphyritic diabase merges into a darker diabase of uniform texture, and beyond that point the rock is almost entirely dark diabase. Occasionally schistose bands are found which, when quartz is present in thin stringers, may be regarded as ore bodies. The width of this principal vein in some portions is as much as 40 feet, but probably will not average more than 20 feet, the extreme width of 40 feet being exposed in one of the stopes.

The shaft which is 7 x 11 feet outside of the timbers is inclined and follows the dip of the vein. Four levels have been opened up at intervals of 100 feet, and the ore is hoisted in a skip to the shaft house, where it is dumped into a second skip and conveyed by an inclined tramway to the mill. The waste rock is removed by small cars to the dump.

Just east of the mill is another large vein which has not yet been opened up. West of the mine at the side of the road going to the office a quartz vein about a foot and a half wide is exposed, and it is stated that this vein is an extension of the Jubilee

vein on H.P. 301, but it is difficult to correlate these two inasmuch as there is some swampy land lying between. A little farther west in a field south of the road leading to Gold Rock a fourth vein is found, but it is exposed for only a very short distance.

The equipment of the engine room and mill consists of four boilers, one of 90-h.p., the other three 50-h.p. each, a double drum hoisting engine, one-half of an Ingersoll Sargeant duplex air compressor which is capable of running six drills, and three mine pumps. The mill is equipped with a Blake crusher having an opening of eight by twenty-four inches, 20 stamps with four amalgamating tables, and a Wilfley table by means of which the pyrite in the ore is separated.

At the time of our visit the mine was closed down, but four men were employed to care for the property and keep it pumped out. There has been a change in the management of this property and it was expected that the mine would be re-opened very soon. A supply of wood for fuel was being laid in.

The buildings on the Laurentian property are in excellent condition. In addition to the shaft house and mill they include a well equipped assay laboratory, blacksmith shop, stable, and comfortable dwelling houses which are lighted by electricity generated at the mine. The magazine is located several hundred feet south of the mine in a tunnel driven into the diabase.

Jubilee Mine

The Jubilee mine on H.P. 301, has been sunk on a vein of quartz which varies in width on its surface from about 18 inches to four feet. Along with the quartz is a schist highly impregnated with siderite or ferro-calcite which increases the width of the vein so that at its narrowest point it is about three feet wide. This siderite schist is similar to the carbonate schist in the west vein of the Regina mine on Lake of the Woods, and to the carbonate schists found in the other mines in the vicinity of Gold Rock. The shaft has some water in it, but is exposed to a depth of about 40 feet and its total depth is said to be about sixty feet. It is stated that good ore was found in this shaft, and it was looked upon as one of the promising prospects in the vicinity. There are no buildings about the shaft, and the property can be considered only as a prospect upon which the development work has been well done.

The Big Master Mine

This mine is located upon location H.P. 366, and is almost directly south of the Laurentian mine. The vein upon which this mine is sunk is similar in many respects to the Laurentian vein, but has been traced for a greater distance and apparently is the same as is found at the Little Master and Volcanic Reef mines. This mine is filled with water, but the mining and milling equipment are in good shape and under the care of Mr. A. Kay. The buildings at the mine consist of a shaft house and a machine shop, and a storage house for supplying an aerial tramway which conveys the ore to the mill about a quarter of a mile distant on the shore of Manitou lake. In addition to the mine buildings, there is a large boarding house and several small cottages for the men connected with the mine.

The equipment at the mine consists of two Jenckes boilers, one hoisting engine, with a three foot drum, one Rand compressor, one engine for the machine shop, one lathe, and three pumps.

The shaft is vertical and has been sunk 300 feet. Three levels have been opened up. The vein which on the surface is about five feet wide is said to increase to eight feet in width on the third level.

The equipment of the mill consists of one Jenckes boiler, one Jenckes engine, 10 stamps, one Blake crusher and four vanners.

The mine has been shut down for a number of years, and considering the length of time that it has been idle the equipment is in good condition.

A weathered sample of the vein material taken from the dump shows a remarkable similarity to the iron formation. It consists essentially of bands of chlorite between which are included lenticular portions consisting largely of carbonate of iron and

quartz, indicating that in all probability this vein is formed directly from the alteration of the surrounding rocks. Adjoining the vein the country rock is diabase and porphyrite which in some places develops a well marked schistosity.

The formation of veins of this character in basic igneous rock occurring in Eastern Ontario is thus described by Prof. W. G. Miller. He states that:

Cracks have been formed in the diorite or gabbro through the shrinkage of the mass itself or by the contraction of the later intruded granite masses which occur in other parts of the district. These cracks have formed channels, at some long distant period before the surface was worn down to its present level by agents of denudation, for the passage of what were in all probability more or less highly heated and impure waters. The waters have acted on the walls of the cracks and have dissolved them away to a considerable extent in many places, thus making cavities which were afterwards filled by the deposition of minerals from solution. Much of the rock matter acted on by these waters still remains in place along the water channels and is now represented by chloritic or biotitic schist. This schist forms a considerable part of the ore, as it contains gold-bearing stringers of quartz and highly auriferous pyrite through it.

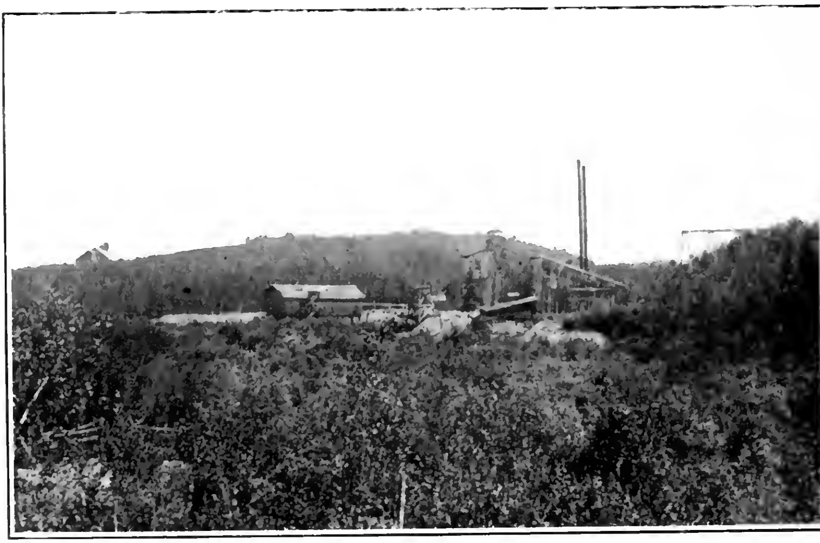


Fig. 16.—Big Master mine, Gold Rock.

A good example of the effects of water in changing an igneous rock of this character into a schist along the walls of cracks followed by the water is seen on the face of a cliff at the Deloro mine in Marmora, where a crack in the rock near the upper part of the cliff runs vertically for a few feet, then turns and runs horizontally, then takes a vertical direction again. The crack followed by the water is very narrow, but is bounded by two or three inches of chlorite schist, the lamination of the schist being parallel to the direction followed by the crack in different parts of its course.[17]

In mentioning the vein at the Victory mine, which is similar to the Big Master vein, Mr. E. T. Corkill states that it "consists of lenses of quartz occurring in a slaty formation or vein filling in the greenstone. This slaty formation is an altered variety of the greenstone."[18]

It would seem from the evidence at hand that the gold-bearing veins in this district have been developed by a conversion of the rock in the fracture zone to chlorite, talc or in some cases to mica, and the formation of carbonates and possibly quartz from the alteration of the rock. Such an explanation would account for the formation, not only of the Big Master vein, but the others in this region.

[17] Miller, W. G., Bur. Min., Vol. XI. (1902), p. 189.
[18] Corkill, E. T., Bur. Min., Vol. XVII. (1908), p. 64.

Fig. 17. Paymaster mine.

Fig. 18. Paymaster mill.

Paymaster Mine

On the west shore of Mud lake on location H.W. 20, is located the Paymaster mine, belonging to the Northern Development Company. At this place a vertical shaft has been sunk to a depth of 325 feet on a vein in altered traps, and three levels have been driven at 100, 200, and 300 feet respectively. From the drift of the first level a cross-cut about 25 feet long has been driven toward the west, on the second level a drift has been extended 80 feet to the southwest and 180 feet to the northeast, and an upraise from the north end of about 90 feet. A cross-cut about 25 feet long has been driven to the west near the shaft, and two other cross-cuts, one 40 feet long, the other 70 feet, have been driven eastward from this level. On the third level the drift has been extended 150 feet to the northeast with an upraise of about 80 feet at the end and a cross-cut about 40 feet long has been driven to the west and another 135 feet toward the east. Going east in this last cross-cut it was found that the ore-body which is a band of schist similar to other veins in this vicinity, with the exception that it shows little, if any, oxidation of iron, has for its walls a dark diabase which is succeeded by a light colored diabase grading into a porphyritic diabase. At intervals schist was found in veins parallel with the one upon which the shaft is sunk. In one of these veins about 25 feet east of the shaft a band of dark quartz a couple of feet wide was seen. Examination of the rocks on the surface led the writer to believe that the schistosity is due to slaty cleavage and has no relation to the strike of the rock, as it crosses the contact of different rocks in almost any direction. It also appeared that there is no reason why the veins should not continue to great depth, although it is known that in some cases, as for an example, at the Sultana mine the veins have pinched out, though at this latter place a new vein was found near the first one and below it. The mine is well equipped both for mining and milling operations. The shaft is provided with a cage 4½ x 4½ feet. The engine room is equipped with a compressor, a double cylinder 8 x 10-inch Lidgerwood hoisting engine, a 250-light dynamo, and a 40-h.p. engine. The mill is equipped with a Blake crusher, 10 stamps and two vanners, and a 65-h.p. engine. There are four pumps about the mine, one of which is located in a pumping station on the shore of the lake and furnishes the water for the mill and boilers. In the boiler house are two 65-h.p. tubular boilers. A comfortable boarding house, office and several cottages provide for the comfort of the management and employees.

The Detola Mine

On location H.P. 411 on the west shore of Mud lake is located the Detola mine. At the time of my visit about 25 men were at work under the direction of Mr. Dryden Smith, manager of the mine. An excavation had been made for erecting a stamp mill, on the shore of the lake, in so-called hydromica schist. The schist is apparently of the same nature as the veins in this vicinity and the nature of the slaty cleavage is well shown in figure 20. The schist, as will be observed, has vertical cleavage and splits easily. At the extreme right of the picture can be seen the smooth face of the schist parallel to the planes of schistosity, while in the centre the cross section of the schist is shown. On July 11th the foundation of the mill was started, and on July 27th the structure had reached the stage shown in the illustration.

At the mine proper the buildings consist of a boiler and engine house, blacksmith shop, shaft house, dry house, and store house. There is also a comfortable house for the manager which is combined with the boarding house, and at a short distance is a lodging house for the miners. Everything about the property is well kept, and every provision seems to have been made for safety and reasonable comfort. The shaft has been sunk vertically to a depth of 235 feet, and two levels have been opened up. The hoisting is done in a bucket, but provision is made for installing a cage at the proper time. A tramway is being built from the mine to the mill so that the ore can be taken directly to the mill for treatment.

A cross-cut has been driven about 100 feet each side of the main vein on the second level, and about seventy feet west of the shaft is a vein consisting principally of schist

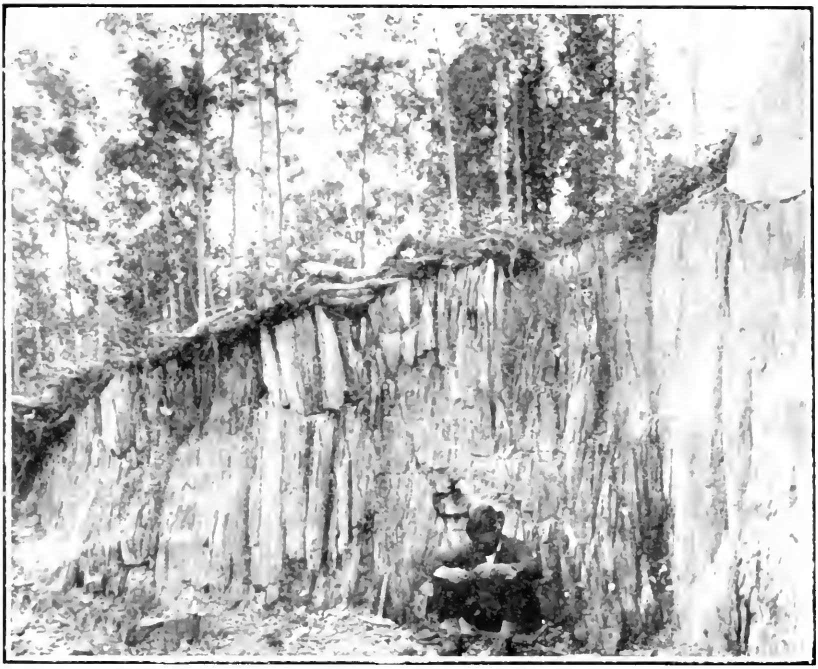


Fig. 19. Altered quartz-porphyry (so called), Detola mine.

Fig. 20. Mill at Detola mine in course of construction.

and calcite. In the east cross-cut about 85 feet from the shaft a banded quartz vein was found; between these veins the rock is diabase, which is to a large extent porphyritic. Nearly west of the mine another vein has been found, which is called the Jack-pine vein. This is in altered trap and is about one foot wide on the surface. Still another vein is located near the northwest corner of the property and consists of a body of pyrite about three feet wide.

The main vein upon which the shaft is located is schistose and carries both quartz and calcite, and appears to be of the ordinary type developed in this region.

Little Master Mine

The Little Master mine is located on claim H.P. 375, near the north end of Mud lake. The veins of this property have been described in earlier reports, and as the boiler house was burned down several years ago and never rebuilt, nothing further can here be added. The boarding house and other dwelling houses are in good condition and are under the care of Mr. John R. MacDonald. The principal vein is apparently a continuation of the Big Master vein, or of a parallel vein at no great distance from it.

Volcanic Reef Mine

This property is on S. 40, which is located just north of the Little Master mine, and the vein upon which the mine is sunk is a continuation of the Little Master vein. The mine is closed down, and the shaft partially filled with water. Information was not secured in regard to the workings, and nothing can be added to the description in the report of this Bureau for 1905.[19]

Foulis Property

The condition of affairs at the Foulis property had not materially changed since Mr. Corkill's report on same.[20] Some work was done during the summer, and late in the season arrangements were made for opening up the mine on a larger scale.

Glass Reef Mine

A visit was made to the Glass Reef mine on July 1st. The new feature at this point is the removal of the mill, which has been sold to the Detola mine, and in consequence the Glass Reef may be looked upon as a mine whose history is finished.

Minnehaha Mine

While waiting for the steamer which was to take our party to Dryden a brief visit was made to Minnehaha mine on the north side of Minnehaha lake. At the time of the visit no work was in progress, but some work had been done earlier in the season. There are two shafts which have been sunk 100 feet on a quartz vein in diabase. Along with the quartz is about 5 feet of schistose vein material similar to that already described in connection with the mines round Gold Rock. A tunnel about 40 feet long has been driven into the diabase to intersect this vein, but as yet there remains considerable distance between the end of the tunnel and the vein. Comfortable buildings have been erected for the camp and offices.

Molybdenite

Near the south end of Smooth Rock lake in the Manitou region an occurrence of molybdenite which is of scientific interest was found by the writer. The rock at this point is mapped by Lawson as altered trap, with which determination the writer agrees. This rock outcrops on the lake between Laurentian gneiss and later granite. In this trap is a vein on location 148 S.V., which carries pyrite, pyrrhotite, gold and molybdenite. A sample taken at random from this vein assayed about $2.50 per ton in gold, and it is reported that the average of former assays is about $10.00 per ton. A shaft about forty

[19] Bur. Min., Vol. XIV (1905), Part I, p. 52.
[20] Bur. Min., Vol. XIX (1910), Part I., p. 79.

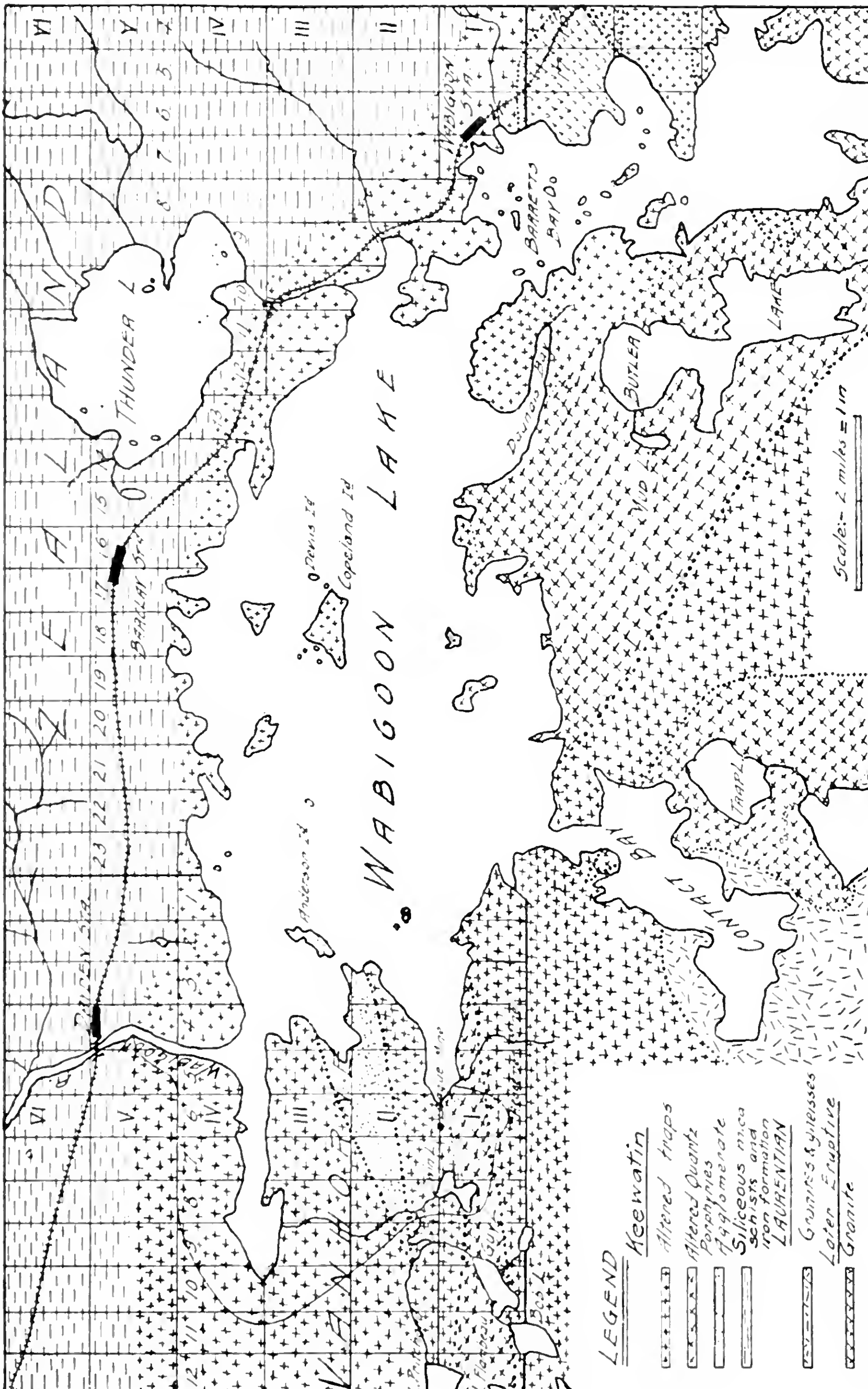


Plate No. 4.—Dryden area.

feet deep has been sunk, and a test pit about ten feet deep put down. The vein is about six feet wide and consists principally of quartz. About an eighth of a mile in a southerly direction from this vein a sample of the trap was broken and small scales of molybdenite found. The occurrence of molybdenite in trap is unusual, as this mineral seems to occur almost uniformly in acidic rocks. Inasmuch as this exposure is near the contact of the trap and granite it is quite possible that the presence of the granite has much to do with the presence of the molybdenite.

The Dryden Gold Belt

The geology of the region around Dryden has been worked out in a general way by Mr. William McInnes in the Manitou lake sheet of the Geological Survey of Canada. During the past summer our party went round Lake Wabigoon and Thunder lake, and upon comparing our results with those of Mr. McInnes, it was found that on the whole our work was in accordance with his so far as could be determined by an examination of the shores of the lakes. Some slight differences were naturally disclosed by our detailed work, and these are set forth in the map accompanying. (See plate No. 4). It was found that the extent of the altered quartz porphyries in the southern part of Van Horne township was not so great as has heretofore been supposed. It was also found that the body of altered quartz porphyries extended in an almost east and west direction in concession 1 of this township, and is bordered on the south by altered diabase and on the north by altered diabase and agglomerate. The agglomerate in this region is principally of the diabasic type, and it is somewhat uncertain just what limits should be assigned to it, but it is probably a much smaller area than is assigned by Mr. McInnes, and possibly a somewhat longer area than is represented in the present map. In the area covered by this map there are six distinct formations shown, which include a granite area near Wabigoon, an area of Laurentian granite and gneiss at the south end of Contact bay, several areas of diabase, altered quartz porphyry and agglomerate, and a broad band of schists containing a well developed deposit of magnetic iron which is mapped as iron formation. In studying the map around Contact bay it will be seen that the formation immediately adjoining Trap lake is marked as altered quartz porphyry, and so far as the formation was seen on Contact bay it represents the general truth, but there are a few small bands of altered diabase, and it would seem probable that these may have a greater development on Trap lake. The continuation of these bands of altered quartz porphyry is represented as a wedge-shaped mass on the northwest side of the bay. It is possible, however, that this extends further west to the south of Van Horne township. The gold mines in this region are located principally in concession 1 of Van Horne township, but a few claims have been taken up on Contact bay, and there is a well-defined vein in lot 5, concession 2, Van Horne, upon which work has been done.

The country round Wabigoon lake is of a rolling nature and as a rule the surface is covered with a deposit of clay loam, which appears to be decidedly sandy. This deposit of clay loam is banded, and apparently is the result of deposition of clay and silt in a large body of water at the close of the glacial epoch. In this banded clay are frequently found concretions of a calcareous nature, and at one or two places it was observed that there were considerable deposits of pebbles which may have been the gravel of an old stream or material deposited by a glacier. The entire area has a low relief, and has apparently been glaciated, though few, if any, glacial markings were observed.

Redeemer Mine

On the southwest forty acres of the south half of lot 6, concession 1, Van Horne township, is located the Redeemer mine. The mine is sunk on a vein consisting largely of quartz, but exhibiting in some parts a felsitic appearance. The shaft has been sunk 235 feet, and two levels have been opened up at 100 and 200 feet respectively. On the

first level drifts have been run 50 feet east and west from the shaft. There is also a drift 65 feet long on the second level. Upon our arrival the mine was filled with water, and was the sole source of drinking water for the camp, inasmuch as the continued drought had dried up all the streams and springs in the neighborhood. The shaft and mill are about 80 feet apart and are connected by a covered bridge leading from the top of the shaft house to the top of the mill. There are two boiler houses, one for the shaft, the other for the mill. The engine rooms are part of the shaft house and mill, and in this respect are a menace to safety because of the possibility of fire. The equipment in the shaft house consists of one boiler, one three-drill compressor, and one hoisting engine. In hoisting the ore a bucket is employed, and the ore is dumped into cars at the top of the shaft house and pushed over the bridge to the mill, where it is dumped on a horizontal grizzley, by which the fine material is separated and sent directly to the stamps, the coarser material being put through a Blake crusher before going to the stamps. There are 10 stamps which are manufactured by the Jenckes Machine Company, Sherbrooke, Que. After

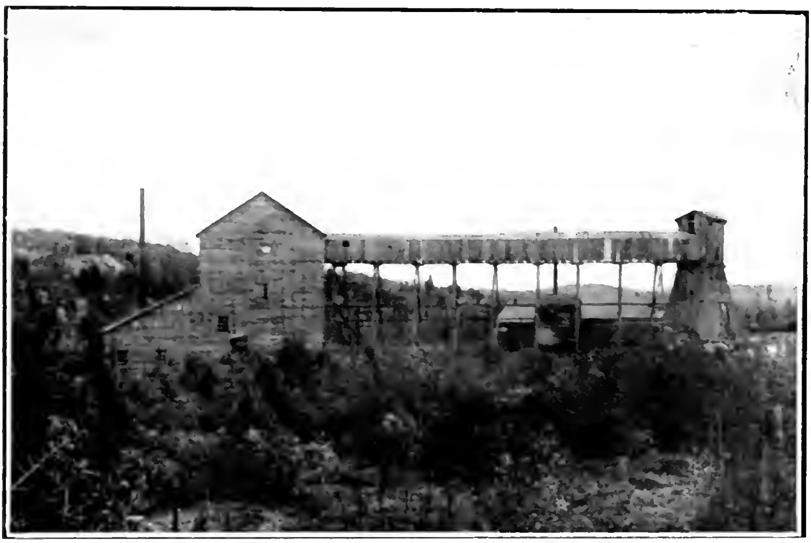


Fig. 21. Redeemer shaft house and mill.

leaving the stamps the crushed ore is passed over an Overstrom concentrator. An experiment was made in cyaniding the ore, old barrels being used as cyanide tanks.

About the time our party left this section Mr. F. B. Roberts, manager of the mine, arrived and began the work of pumping out the mine. Before this could be done it was necessary to make some repairs to the boilers, and he estimated that it would be about a week before the second level would be opened, so that, in consequence it was impossible to go down in the mine.

The Redeemer camp is equipped with a comfortable boarding house, lodging house, and office for the manager.

Golden Park Claim

On the north side of Williams bay, in lot 5, concession 2, of Van Horne township, is a location known as the Golden Park, upon which two shafts have been sunk on a quartz vein about 6 feet wide. The vein is in trap and contains considerable pyrite and siderite as well as traces of chalcopyrite, malachite, and azurite. No work was being done at the time of our visit.

League Mine

The north half of lots 5 and 6, concession 1, Van Horne, are owned by the Shareholders Protective League, Limited. The principal openings have been made on lot 6, where two shafts have been sunk in an altered quartz porphyry which has developed a certain degree of schistosity and may be looked upon as a breccia. In this rock is a vein which varies considerably in texture, and seems to grade from a quartzite to a felsite. The first shaft sunk is 80 feet deep and is 7 x 9 feet. The second shaft upon which work was in progress is also 7 x 9 feet, and had reached a depth of 36 feet at the time of our visit. The equipment had been removed from the first shaft to the second shaft and consists of a boiler, and small hoisting engine. Mr. J. J. Kaighin is superintendent, and there were four men working.

Other Gold Claims in Van Horne

On the southeast 40 acres of the south half of lot 10, concession 1, Van Horne, a shaft has been put down on an irregular vein about seven feet wide. The country rock is diabase, but the vein is not far from the contact of diabase and altered quartz porphyry. In the vein are several horses, so that the width of vein material is probably not more than 3½ feet. At the time of our visit the shaft had been sunk about twelve feet. This claim is owned by Mr. Pitt, of Dryden, and the development work was being done by Messrs. A. McPhail and D. Hutchinson.

On the south 80 acres of the north half of lot 8, concession 1, Van Horne, is the Good Luck claim, which has been taken up by Messrs. A. McPhail and D. Hutchinson. Two veins have been exposed on this claim. The north one is about three feet wide and consists of banded quartz, siderite, talc and pyrite. The south vein is about three and a half feet wide. It shows considerable free gold, and at two spots on the surface of this vein the writer found visible gold. A test pit has been sunk here, and the samples taken out frequently show visible gold.

During the summer a forest fire swept over much of the Dryden gold belt, and the buildings at the Ideal mine were burned, so that nothing further can be added to the former reports on development of this property.

The Lone Jack claim is on Bob lake in the south half of lot 11, concession 1, Van Horne township, and upon the property there is a well mineralized vein about 15 feet wide, which is highly impregnated with pyrite. Several test pits have been sunk on the vein and some stripping has been done.

On A. L. 88, near Flambeau lake, is a promising vein, about 6 feet wide, of which about two feet is nearly pure quartz, while the rest consists of quartz and siderite. North of this vein is another one about eighteen inches wide. It is possible that the two veins may come together.

On R. 545, a test pit has been sunk in altered felsite which is cut by numerous quartz veins. Presumably this rock is the same formation as that found at the League mine, but the rock here is somewhat mixed, as in addition to the felsite there is considerable trap, so that it is apparently near the contact of the two. The test pit was nearly filled with water, and only surface indications could be observed.

North of Guy lake in lot 10, concession 1, Van Horne, Mr. J. R. Walker has sunk a shaft about 50 feet deep in an altered felsite or granite. The veins are small, being not more than about a foot wide, but it is reported that assays of samples from this claim have gone as high as $19.40. On the same claim are three large quartz veins running from two to six feet in width upon which shallow openings have been made but no shaft sunk.

The southwest 40 acres of lot 10, and the southeast 40 acres of lot 11, concession 2, Van Horne, have been taken up by Mr. H. A. C. Machin, M.P.P., and the development work has been done near the boundary of the two. A quartz vein about a foot wide shows on the surface, but decreases in width at a depth of about four feet.

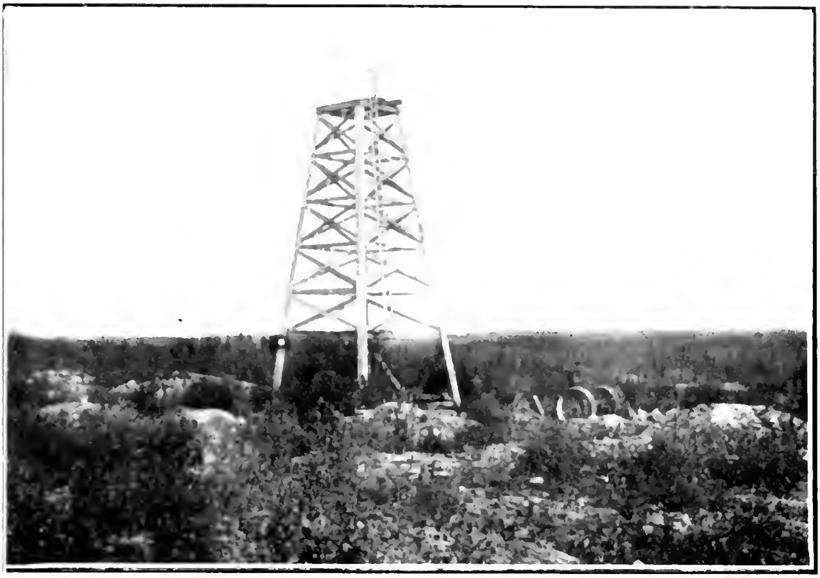


Fig. 22.—League mine, No. 1 shaft.

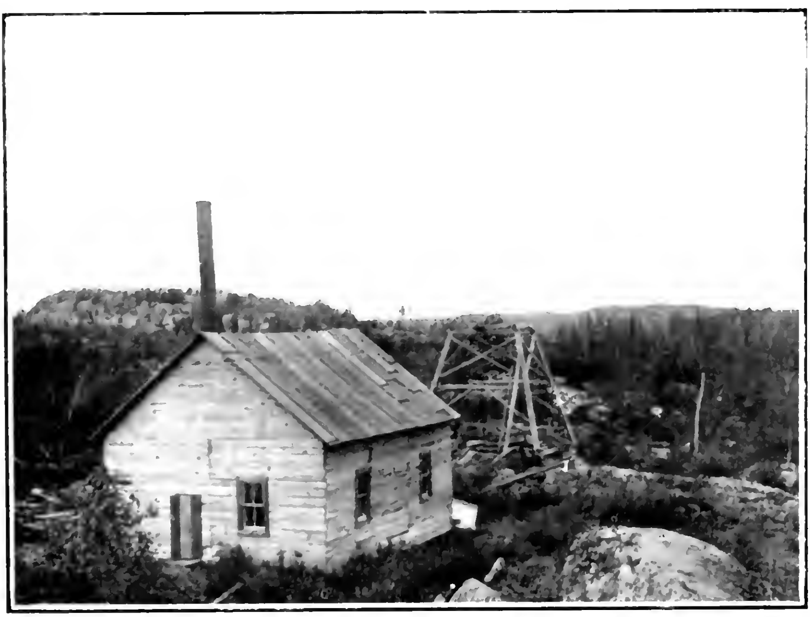


Fig. 23.—League mine, No. 2 shaft and boiler house.

On the northwest 40 acres of lot 11, concession 1, is a vein which has been stripped for about 100 feet. This vein is about 2 feet wide, and consists principally of quartz with some pyrite. The country rock is felsite with which is associated some diabase. The indications here are promising.

The vein at the Gold Moose mine is about 18 inches wide and a shaft has been sunk to a depth of about 60 feet. The vein is quartz in a country rock of trap. The mine was idle at the time of our visit.

On the northwest 40 acres of lot 7, concession 1, is a quartz vein which varies in width from one to three feet, which is near the contact of felsite and trap. Aside from a little stripping no development work was seen.

The Lost mine is owned by Mr. C. Larson, who has sunk two shafts about 300 feet apart to a depth of 22 and 54 feet respectively. The vein is at the contact of trap and felsite, and varies from 2½ to 6 feet in width, but occasional horses may be seen. The vein has been stripped for a considerable distance, and Mr. Larson reports visible gold in the quartz. The vein looks promising, and the development work has been well done.

In lot 5, concession 1, Van Horne, are two claims owned by Messrs. Hays and Campbell, respectively, upon which development work has been done by sinking test pits. In both cases quartz veins are found in trap, and these veins may possibly be an eastward extension of the Redeemer vein.

Several claims have been taken up on Contact bay, but the only development noticed was on the east side of the bay, and as no one was around it was impossible to ascertain the claim number. At the place where development work was seen two test pits from 20 to 30 feet deep had been sunk and some of the work had been done within a few days. The principal development work in this region has been done by Mr. J. Holmes.

Iron Ore

Between Dryden station and Thunder lake is a deposit of magnetic iron ore, which occurs about the middle of a deposit mapped by Mr. McInnes as "highly altered Keewatin rocks, principally mica, schists and fine gneisses." This formation, however, should undoubtedly be classified as iron formation. The width of the iron-bearing body about three miles east of Dryden varies from 100 to 200 feet, and consists of alternating bands of magnetite with quartz and some hornblende and mica. On the west side of Thunder lake a continuation of this same body of ore is found, and the deposit is said to be continuous for about two miles. The deposit is banded and in some portions highly contorted. A sample taken on Thunder lake shows alternating bands of quartz, magnetite and hornblende, with occasional traces of pyrite. The magnetite is very fine grained, and the ore has a lean aspect, but it is possible that by magnetic concentration a workable grade of ore can be obtained. The rocks accompanying the magnetite are principally mica schists which are more or less garnetiferous. Considerable quartz is present in these rocks. The contorted character of the ore body is rather striking (see fig. 25), particularly as the adjoining rocks have more uniform banding.

Molybdenite

Mr. C. D. Coates, of Dryden, showed the writer samples of molybdenite which were stated to occur in a pegmatite from a granite region south of Gull lake at a point seventeen miles northeast from Dryden. Several crystals were more than an inch in diameter.

Eagle Lake Region

The trip on Eagle lake was made with a view of examining the gold deposits in the southwestern part, so that little detailed work was done in other parts of the lake.

Fig. 24.—Iron formation, Dryden.

Fig 25. Iron formation, Dryden.

The geology of this region has been worked out by Mr. Wm. McInnes in the Manitou lake sheet of the Geological Survey of Canada. In the main the geology as outlined by him coincides with the writer's conclusions, but on the large island south of Indian Reserve No. 27 the observations of the writer led him to designate the rock which is mapped as agglomerate, as altered felsite or quartz porphyry. Inasmuch as our party was without a copy of Mr. McInnes' map no examination was made on the east shore of the lake at this point to determine whether this rock might not be found on the main shore, as it was supposed that this outcrop was a continuation of the formation shown on the west side of Wabigoon lake, and it is almost in line between the altered felsites a short distance to the west on Eagle lake and those on the west side of Wabigoon lake. It is desirable that further investigations be made here to determine the relations.

Building Stone

The granite in the southwestern part of Eagle lake is well adapted for building purposes, but is open to the same objection that applies to the granites of Lake of the Woods, namely, there are no proper transportation facilities.

Iron Deposits

It was reported to the writer that iron deposits are to be found on Net island and North Twin island. An examination was made to find these bodies, but no trace of them could be seen, and although the dip-needle was used along the shores, no noticeable deflection was observed.

About a half mile south of Eagle river station, is an outcrop of banded schistose rock which is undoubtedly iron formation, but so far as seen it does not contain any great quantity of iron ore. This rock has been traced by Mr. McInnes eastward from this point through Dryden to Thunder lake and beyond.

Meridian Bay Mining Company

On the west side of Meridian bay of Eagle lake is located the property of the Meridian Bay Mining Company. Upon it is a vein extending nearly north and south, which is composed principally of pyrrhotite, chalcopyrite, and pyrite. The width of the vein varies from 3 to 12 feet, and Mr. J. E. Stanton, the manager, reports that it contains from one-half to one per cent. of nickel, in addition to copper and gold values. The vein has been stripped for about two hundred feet, and an opening about 25 feet long has exposed the vein for its full width to a depth of about 10 feet. A good sized pile of ore has been taken out and several tons have been roasted. The appearance of the ore is good, and in case more ore of similar character were found it would probably pay to work it for the copper content. The vein lies in a coarse diabase or gabbro. A comfortable camp has been erected here, and further developments will be watched with interest.

Grace Gold Mine

The Grace mine is located on the west side of Eagle lake near the contact of Laurentian granite and altered quartz porphyry of Keewatin age. Six veins have been located on this property and a shaft has been sunk 135 feet on what is known as No. 1 vein, and in this mine one level has been opened up. The vein is much the same type as those seen in the Manitou region, and consists principally of schists with some bluish quartz. In addition to the shaft a tunnel has been driven into the hill 160 feet. A stamp mill has been erected, the equipment consisting of a Blake crusher, five stamps, an engine, one boiler, two vanners, and a small hoisting engine. A well equipped camp has been provided for the comfort of the workmen. The mine was idle at the time of my visit, but it is in charge of a caretaker who made our party very comfortable during our stay.

Baden-Powell Mine

The Baden-Powell mine of the Northern Light Mines Company is located on South Twin island in the western part of Eagle lake. The country rock here is granite, probably of Laurentian age. Three quartz veins are visible on the surface and test pits have been sunk on all of them. A shaft has been put down 135 feet.

A stamp mill erected on this property has for its equipment a Blake crusher and five stamps, with amalgamating table, a boiler and an engine. At the shaft a small hoisting engine with an 18-inch drum brings the ore to the surface, and a tramway connects the mouth of the shaft with the top of the mill. The property was not working at the time of our visit.

Eldorado Mine

On claim M.H. 257 is located the Eldorado mine, owned by the Northern Light Mines Company, whose head office is located at 628 Prudential Building, Buffalo, N.Y. This claim is on the west side of Eagle lake in an area of Laurentian granite. A shaft has been sunk, but as considerable water was in the shaft and no one was on hand to give any information, it can only be said that the prospectus of the company states that it had been sunk twenty feet, but the amount of waste rock would indicate that the shaft was deeper. A mill has been erected near the shaft which has a gyratory crusher, two gravity stamps, and an amalgamating table, one boiler, one small hoisting engine, one engine for crusher, and a pump.

Fig. 26. Grace mine, Eagle lake.

Pyrrhotite Deposits

On account of the discovery of pyrrhotite south of Ingolf, our party went to this place in company with Mr. H. P. Thomas of Kenora, and made a hasty examination of a few claims. The pyrrhotite runs in two or more parallel bands nearly east and west, and is found extending from a point two or three miles east of West Hawk lake to a point several miles west of the west end of the lake. Much of the rock with which the pyrrhotite is associated is schistose and resembles the iron formation near Dryden, except that the iron present is combined with sulphur rather than oxygen. The width of

the pyrrhotite bodies varies considerably, but in one place east of West Hawk lake the main body was about 150 feet wide, while the rock accompanying it appears to be well impregnated with it for a width of several hundred feet, as evidenced by the rusty character of its outcrop. This body of pyrrhotite carries gold values; nickel has been looked for, but up to the present only very small percentages of this metal have been detected by analysis.

The writer wishes to acknowledge the many courtesies and favors which were extended to him during the summer. It is impossible to mention each one individually, as this would involve making a list of nearly all with whom he came in contact. He would, however, make particular mention of H. A. C. Machin, M.P.P., of Kenora, who not only extended hospitality to the party before our equipment was ready, but took us in his launch to the Mikado and Regina mines. Mr. Dryden Smith, manager of the Detola mine, not only moved our camp equipment for us twice, but assisted in locating many of the claim lines, and rendered many other favors which were much appreciated. Mr. Dixon, of Dryden, who transported us from Minnehaha lake to Dryden, rendered us a favor which is remembered with gratitude. Finally, the advice and criticism which have been given by Prof. A. P. Coleman of the University of Toronto are acknowledged with thanks.

VERMILION LAKE PYRITE DEPOSITS

BY E. S. MOORE

Introduction

The Vermilion Lake pyrite deposits are situated in the vicinity of Big Vermilion lake. During the past summer the writer, in accordance with instructions received from the Provincial Geologist, prepared a report upon the geological features of these deposits. Accompanying the report is a key map of the region, showing the relative position of the several deposits, concerning the location of which information could be obtained, and a map on the scale of 40 chains to the inch covering the area in the vicinity of Vermilion pyrite mine. Owing to limited time a larger map of the Vermilion lake region was not prepared, and those desiring further information than that given on these maps are referred to the large map of this region published by the Department of Mines at Ottawa.[1]

Owing to the thickness of the drift great difficulty was experienced in working out the rock relationships in the vicinity of the Vermilion mine, as it was only where development work had been done that the deposit was exposed. The deposit at this mine is the only one upon which a large amount of development work has been done, and it gives promise of being an important producer of iron pyrites for the manufacture of sulphuric acid.

It is matter for regret that the officials in charge of the Vermilion mine could not see their way clear to give, for publication, quite as much information about the property as was desired, yet I feel highly indebted to Mr. H. V. Smythe, superintendent of the mine, and other members of the mine staff, for their cordial hospitality and assistance while engaged in work in that vicinity.

Geographical Position and Extent of Pyrite Area

Vermilion lake, or Big Vermilion lake, as it is often called, lies about five miles southwest of the new village of Graham, on the National Transcontinental railway. It was formerly reached from Dinorwic, about 35 miles distant, on the main line of the Canadian Pacific railway, by a wagon road and canoe route, but at the time of my trip we travelled by canoe from Superior Junction, although the new railway line passes within about three miles of the lake and is at present connected by an aerial tram. Our route lay down the Sturgeon river to Abram lake, through this and Pelican lake and thence up the river to Vermillion lake. The canoe route is good, as the current in the Sturgeon river is slow, and the only rapids or falls met with are Frog Rapids (which are almost negligible), at the outlet of Abram lake, a rapid about 300 yards long in Vermilion river up which we towed the canoes, and Vermilion Falls with a drop of about ten feet, necessitating a very short portage. When the Vermilion river is low there is barely enough water for canoe travel below the falls. On this trip the rocks observed were chiefly green schists, greenstones and granite, but a fine outcrop of Lower Huronian conglomerate (Fig. 1), was seen along the north shore of Abram lake, nearly opposite "Abram's Chute." The rock contains large granite boulders, some as much as 18 inches in diameter and well rounded. There are also greenstone, vein quartz and iron formation pebbles. The rock is considerably sheared and many of the pebbles are elongated.

Vermilion lake is about 15 miles long and a maximum of three wide, and has many islands scattered through it. One fails to see the appropriateness of the name, as the water is beautifully clear, and the gossan on its shores is not at all striking.

The accompanying map will show the relative position of the various pyrite deposits. The most important one, the Vermilion Pyrite mine, lies at the east end of the lake, while the other bodies were found between this mine and Pelican lake and on an island near the west end of the lake. The latter deposit is about 8 miles west of

[1] Explored Routes in a Portion of Northwestern Ontario between Lake Minnitaki and Lake of the Woods, Dept. of Mines, Canada, 1909, Map No. 1061.

the mine, but it is suggested that it may be along the same general line of fissuring as the vein at the mine, because its projection would lie along a line near the mine and along the general strike of the rocks in the vicinity.

Although in two reports[2] a deposit of pyrite is mentioned as occurring on the shore of Vermillion lake, about eight miles west of the mine, nothing is said about an island, and it is thought that the vein on this island may be the one to which reference is made, as no information was received from the Mining Recorder or the officials at the Vermilion mine regarding any deposit located on the shore. The deposit is called the Fanning prospect by Fraleck. An observation of the accompanying maps will show that all the deposits occur within a narrow area, which is about 12 miles in length.

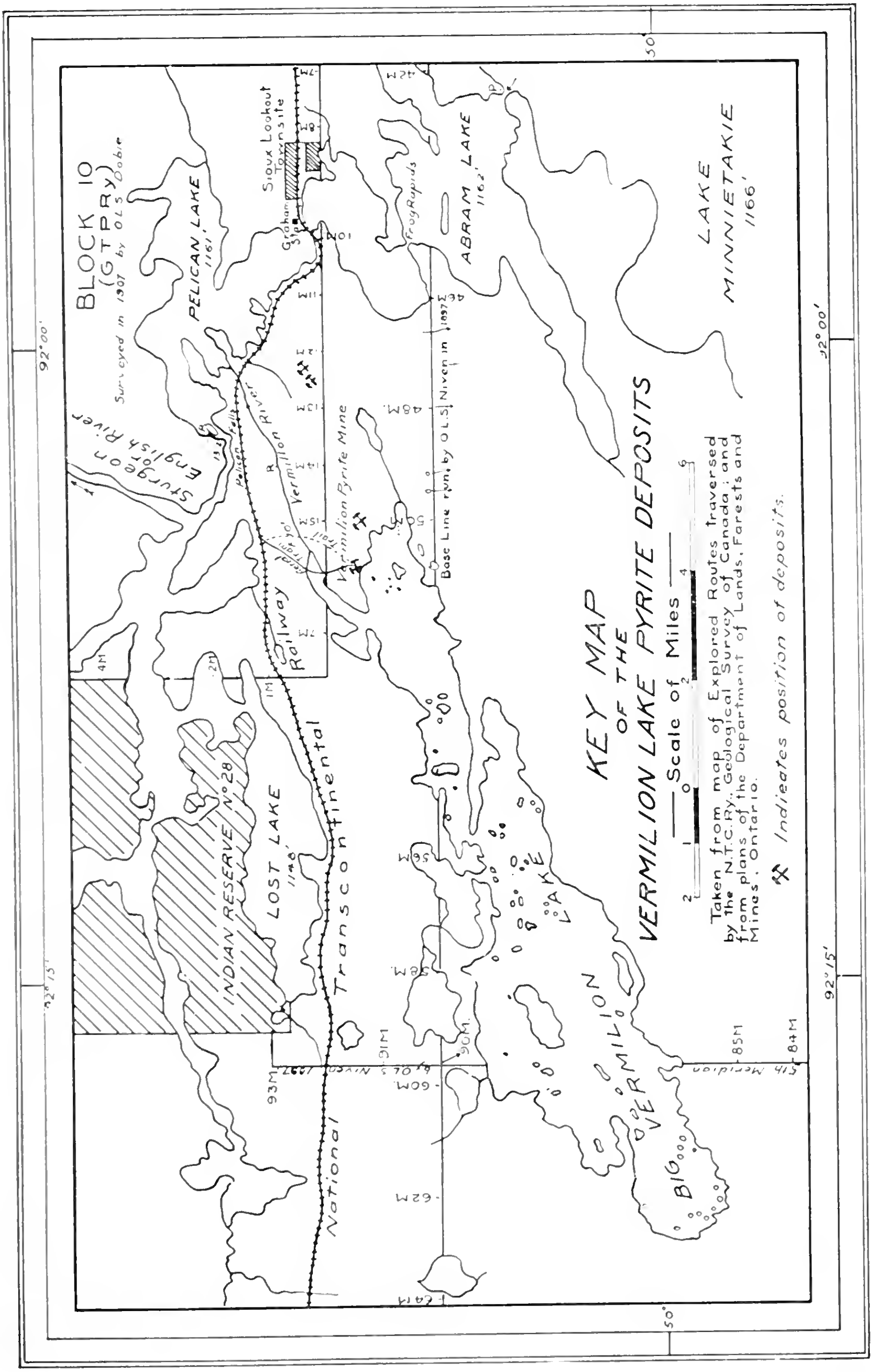
Fig. 1.- Lower Huronian conglomerate, Abram lake.

Historical Geology of the Area

Rocks of the Area

The rocks in this area consist of a complex of indefinite age, since there is no fixed geological horizon by which the ages of the various formations can be determined. This complex consists largely of greenstone, often showing pillow or ellipsoidal structure, and green schists frequently of indefinite origin, but derived from basic igneous rocks, and apparently graywackés and arkoses. Plagioclase feldspar-porphyries may be seen with phenocrysts one-quarter inch in diameter. A large mass of diabase occurs along the footwall of the pyrite deposit at the Vermilion mine, and although portions of this rock are much weathered some of it appears much fresher than the bulk of the greenstones in the region. Narrow bands of recrystallized cherty iron formation interbanded with black graphitic slates occur along the south bank of the Vermilion river

[2] Iron Pyrites in Ont., E. L. Fraleck, Bur. Min., Vol. XVI. (1907) p. 177, and W. H. Collins, Region between Lake Nipigon and Clay lake, Ont., Dept. of Mines, Canada, 1909, pp. 61-2.


KEY MAP
OF THE
VERMILION LAKE PYRITE DEPOSITS
Scale of Miles
Taken from map of Explored Routes traversed by the N.T.C.Ry., Geological Survey of Canada; and from plans of the Department of Lands, Forests and Mines, Ontario.
Indicates position of deposits.
BLOCK 10
(G.T.P.Ry.)
Surveyed in 1907 by O.L.S. Dobie
PELICAN LAKE
1161'
ABRAM LAKE
1162'
LAKE
MINNIETAKIE
1166'
LOST LAKE
INDIAN RESERVE No 28
National Transcontinental Railway
BIG VERMILION LAKE
Vermilion Pyrite Mine
Vermilion River
Sturgeon or English River
Pelican Falls
Sioux Lookout Townsite
Frog Rapids
Base Line run by O.L.S. Niven in 1897
92° 00'
92° 15'
50°

and along the north side of the deposit at the mine. What appears to be a narrow band of metamorphosed sandstone occurs near the hanging wall, and fragments of it may be seen on the dump.

The rock forming the hanging wall of the mine and stretching away to the east is a schistose basalt-breccia, composed of fragments of very fine-grained basalt, cemented by quartz and calcite. The fragments now consist chiefly of uralite and zoisite, secondary minerals due to alteration of the primary ones, augite and calcium sodium feldspar.

On Pelican lake, at the eastern extremity of the area, there is a large mass of epidote-granite, extending west into the most easterly of the nineteen claims surveyed in this area. It is a very handsome granite, of a reddish color, with yellowish-green specks of epidote scattered through it.

As it is impossible to definitely fix the age of these various rocks, the greenstones, schists and iron formation are tentatively regarded as Keewatin in age, and the granite as Laurentian, *i.e.*, post-Keewatin and pre-Huronian, although its massive character and other resemblances to some later granites further east suggest a later age for it. The quartzite and diabase may be Huronian, in which case the granite would be regarded as post-Huronian.

Outline of Geological Events

The series of geological events which are supposed to have occurred in this area include extensive volcanic activity, producing the intrusive and extrusive basic and acid rocks. These rocks include the ellipsoidal greenstones, diabases and quartz-porphyries. The diabase along the footwall of the mine may have originated at this time or later. On top of these rocks were laid down small amounts of cherty iron formation, with black slate, arkose, graywacké, and later a little sandstone.

These rocks all suffered extensive metamorphism and the schists resulted.

Following, or perhaps accompanying, this metamorphism, occurred the intrusion of the granite, and although this cannot be asserted with any degree of certainty, it is thought that the solutions bearing iron and sulphur may have entered fissures formed at this time along lines of weakness between different masses of the earlier rocks, as, for example, between the diabase and the basalt-breccia, which was probably formed by crushing at the time the fissure was developed. The reasons for the supposition that this was the sequence of events will be discussed under the heading, Genesis of the Pyrite.

The question of the relative age of the pyrite and a large quartz vein which cuts through it in the mine and runs off through the schists about one-third of a mile to the east is difficult to settle. In view of the fact that vein quartz is associated with the pyrite not only at the mine but in the band of iron formation lying along the south side of Vermilion river, in the small deposits on claims H.W. 778 and 779 and on the island in Vermilion lake, as well as in the deposits in many other places in Ontario, it seems reasonable to regard it as a gangue mineral with the pyrite, having been deposited at the same time. It is found, however, that at the mine the quartz forms a more or less tabular mass about 12 feet wide, cutting through the centre of the sulphide body, and it fills small cracks in the pyrite, as if fracturing of the pyrite permitted the infiltration of the quartz. As crystals of pyrite and a little sea green talc also occur in these cracks with the quartz, it may be that the quartz and pyrite in them represent small amounts which have been taken into solution and re-deposited along these lines.

The presence of the quartz vein in the central portion of the pyrite body might be explained on the supposition that the quartz formed early in the process of vein filling, and that the fissure later widened, permitting the pyrite to come in on either side. A parallel interbanding of pyrite and schist along the north side of the deposit suggests this re-opening of the fissure.

Further evidence regarding the relation between the pyrite and quartz may be found in the basalt-breccia along the hanging wall of the deposit. The fragments of

Fig. 2. Big Vermilion lake from Vermilion pyrite mine.

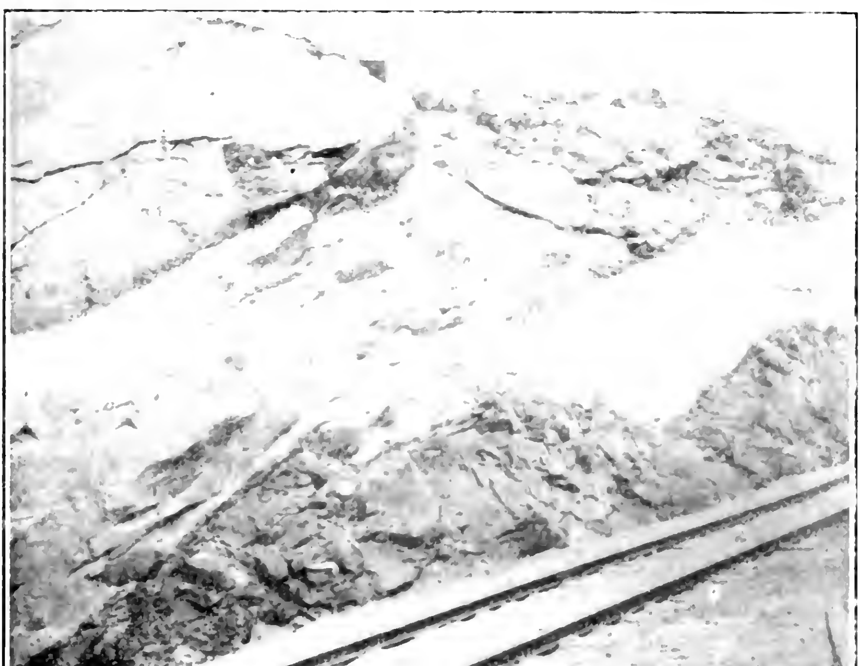


Fig. 3. Granite dike in greenstone near Pelican lake, G.T.P. Ry.

the breccia are cemented by calcite and quartz, and there is a little pyrite with them. That there is not more pyrite may be due to the fact that these spaces were early filled with quartz and calcite before the stronger pyrite solutions appeared, or this breccia may not have been formed until a later time and perhaps at the time the quartz vein was formed. Further work in the mine may throw more light on these relations.

Description of the Various Deposits

Vermilion Pyrite Mine

This property is the only one which has been worked. It includes the claims H.W. 715 and 716, purchased from J. Shilton, and lies on the eastern shore of Vermilion lake. It was discovered a good many years ago by a prospector observing the red gossan on an outcrop of pyrite and pyrrhotite on the edge of the lake, the only place where it outcropped, because of the thickness of the drift in this vicinity.

The mine has been known by various names, such as the Michie mine, the Northern Pyrites and the Vermilion Pyrite mine. It is controlled by the General Chemical Company, which also controls several mines in eastern Ontario, and which has sulphuric acid manufacturing plants at Detroit, Michigan.

Mine Workings

The workings at the mine have been described by several writers, E. T. Corkill, Mine Inspector,[3] E. L. Fraleck,[4] and W. H. Collins.[5] Messrs. Corkill and Collins regarded the deposit as a true fissure-filling, while Mr. Fraleck considered it as a replacement in the schist. The former determination seems to be the correct one.

These workings consist of two shafts, No. 1, in the hanging wall, about 250 feet, and No. 2, on the footwall, 230 feet deep. The former is a vertical shaft, the latter follows the dip of the rock at about 65° north. In No. 1 there are levels at 85 feet and 145 feet. At the first level, the point where the shaft struck the pyrite, a cross-cut has been driven south 74 feet across the deposit, and at the second level the cross-cut south to the footwall is 65 feet and north to the hanging w 16 feet. On the second level there is a drift east 175 feet and west 50 feet. On the footwall side of the vein a drift runs east 110 feet and west 30 feet.

No. 2 is a two-compartment shaft lying to the east of No. 1 and connected with it by a drift 400 feet long. At the time of my visit a cross-cut had been run north 30 feet across the vein and a short drift east along the footwall. All the cross-cuts and drifts mentioned above lie in pyrite, and there is already blocked out a large mass of the sulphide. Above the second level there is a large stope, from which it is said 10,000 tons of pyrite were taken out in 1909, and shipped by the aerial tram which connects the mine with a spur on the Transcontinental railway about two miles distant. No shipping is being done at present, and the property is being developed by underground work and storing of the material in dumps on the surface, since the bins at the railway track collapsed about a year ago.

On the surface pyrite is disclosed in pits 400 feet northeast of No. 1 shaft, 150 feet southwest and again about 350 feet southwest at the shore of the lake. Mr. Fraleck states that borings in the lake 200 feet from the shore are said to show high grade sulphide.

The Sulphide Body

The term "ore-body" has frequently been used in speaking of this deposit, but it seems scarcely appropriate since no metal is extracted from the mineral. Some of the iron from the Spanish sulphides is used in blast furnace work, probably because they contain some copper, and where copper is present it is easier to get rid of the sulphur, but our native sulphides do not appear to be used in the manufacture of anything but sulphuric and other acids.

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[3] Bur. Min., Vol. XVIII. (1909), p. 83; also Vol. XIX. (1910), p. 79.
[4] Ibid., Vol. XVI. (1907), p. 176.
[5] Dept. of Mines, Canada, Lake Nipigon to Clay Lake, 1909, pp. 61-2.

Fig. 4. Vermilion pyrite mine as seen from Vermilion lake.

Fig. 5. Vermilion pyrite mine from hill southeast of the mine.

From the outline given above of the development work at this mine it is evident that there is a very large body of sulphide blocked out. The mass is comparable in purity and extent to some of the large sulphide bodies in the Sudbury region. It lies between a clear-cut footwall of old diabase, which is fairly regular in outline, and a hanging wall of schist, composed chiefly of a brecciated basalt. Narrow bands of schist are in some cases interbanded with the pyrite, but on the footwall there is little pyrite in the country rock. The main mass of the deposit is nearly pure pyrite, with a little pyrrhotite in places and some sulphide, which is lighter in color than most pyrite and may be marcasite, but on account of being massive its crystal form could not be determined. The analyses are said to show from 45 to 48 per cent. S, which is a little below the theoretical percentage in pyrite (53.4 per cent.).

Mr. Smythe, the superintendent, said he did not know whether the ore contained any gold or not, as he had not had analyses made to determine the presence or absence of this metal.

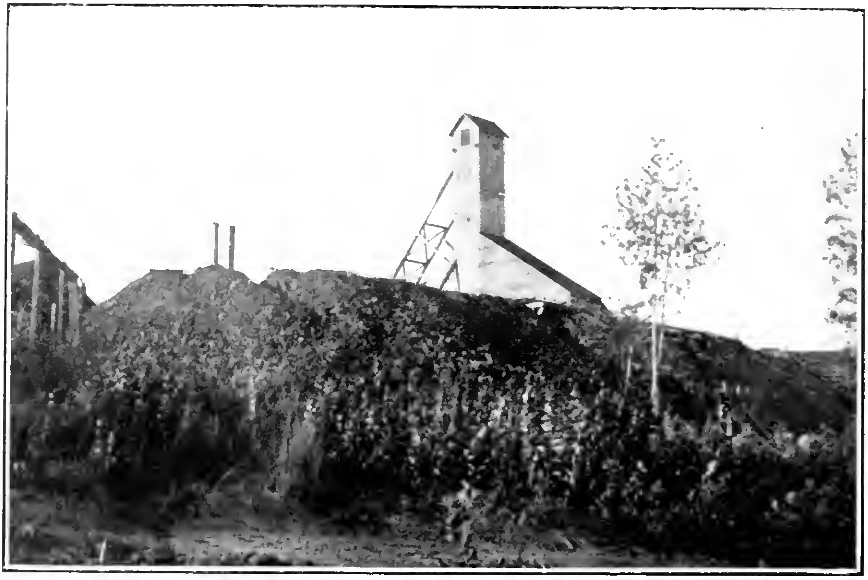


Fig. 6. Vermilion pyrite mine, No. 1 shaft house and dump.

Near the centre of the vein there is a mass of quartz about 12 feet wide mixed with the pyrite. This same vein may be seen on the surface about 400 feet northeast, where it is about four feet wide. A little sea-green talc and chlorite occur along cracks in the pyrite, with crystals of quartz and pyrite.

The vein is wider at the west end of the working than at the east, and this may indicate a pinching in that direction, but on account of the drift nothing can be determined on the surface regarding the size of the vein. In depth the deposit holds its width well so far as the development work has gone.

Oxidation of Pyrite

The oxidation process in pyrite is well illustrated on the dump at the mine. Where a pile of crushed pyrite has stood for a couple of years large masses have altered, under the action of rain water, to melanterite, the hydrous, ferrous sulphate of iron ($Fe\ SO_4 + 7\ H_2O$), which is readily recognized by its astringent taste. It occurs in greenish and grayish-white colors, and when mixed with the red oxide gives yellowish and reddish hues. The oxidation has extended to a depth of four or five feet in the pile and botryoidal and rudely stalactitic forms of the sulphate have resulted where the material overhangs.

Other Deposits of Pyrite

Besides the Vermilion mine there are other deposits which are of lesser importance. On the south shore, near the point where the aerial tram crosses the bay on Vermilion lake, there is some pyrite in a banded sugary quartz and black slate, which is regarded as metamorphosed iron formation. The pyrite here is distinctly later than the iron formation, and is accompanied by vein quartz. It is of no importance economically.

Tindall's Claims

On the east end of an island in Vermilion lake, about eight miles west of Vermilion mine, there is a deposit of pyrite on what is known as Tindall's claims. On this island there is a pit upon a hill a few rods from the shore, in drift about 15 feet thick. In the bottom of the pit there is a vein about two and a half feet wide, composed of nearly solid pyrite. On the south side of the vein the rock is a schistose quartz-porphyry, containing small crystals of pyrite. The rock on the north side could not be determined, because of its altered condition and the drift cover. The drift overlying the pyrite is stained and cemented with iron oxide. In a hole in the drift, about four feet from the bottom, a decomposed boulder of vein quartz and finely disseminated manganese dioxide was found. The result is a dark granular mixture of silica and pyrolusite.

At the stripping on the lake shore the pyrite vein varies in width from three to four feet, but is not so pure as in the first pit mentioned. It carries some quartz, and cuts the schistose quartz-porphyry in such a way as to leave no doubt of its vein character. The strike of the vein is about 80 degrees, and this strike would carry it near the small island to the east of the one upon which the vein is seen. No pyrite was found in place on this small island, but some iron-stained schist and a block of pyrite more than one foot in diameter were seen on the south shore. A further projection of the vein would carry it somewhere near the Vermilion pyrite mine, and it is possible that the two veins are located along the same general line of fissuring. It will be interesting to see whether future prospecting will disclose any deposit on a line between these two.

Pits on Claim H.W. 762

Lying close to the winter road near the southwest corner of H.W. 762 there are four pits in the drift. The drift is stained with gossan, but no pyrite of importance was seen in place. In one pit a little banded quartz and magnetite was seen. These pits are located near the edge of the basalt-breccia, but are not considered to be in the same line as the vein at the mine, since the strike of 50 degrees, common to the rocks there, would carry the projection of the vein north of these pits.

The Schmidt Claims

We were informed that several claims in the eastern part of the group are owned by a Mrs. Schmidt. On claims H.W. 778 and 779, the next claims east of H.W. 762 which show any pyrite, there are some pits and trenches. The pit on H.W. 778 is about eight feet deep and runs into the side of a hill. The sulphide consists chiefly of pyrite, with a little pyrrhotite. In spots the pyrite is almost solid, but in other places it is much mixed with rock, either greenstone or altered quartz-porphyry, and an altered granite dike about one foot wide is associated with the deposit. It looks as if the sulphides, accompanied by a granite dike, had come in along a line of weakness between the acid and basic rocks.

The pit on H.W. 779 is situated, with reference to the last pit described, on a line along the strike of the rocks. This pit is three feet deep by five feet in diameter and located on a mass of pyrite in a schistose quartz-porphyry. Neither of these deposits has yet shown any claim to economic importance.

Genesis of the Pyrite Deposits

In looking over the descriptions of iron pyrite deposits in Ontario, Spain and parts of the United States, one finds that the deposits occur generally along contacts between schists and massive igneous rocks, along contacts between igneous rocks, acid or basic, and crystalline limestone, or as bands in banded iron formation, consisting of cherty silica and pyrite. Associated with the pyrite the chief impurities are calcite and quartz, in small quantities. Almost all of these occurrences, except the latter, suggest fissure fillings or replacements along a line of fracturing or faulting, but the source of the sulphide is very often not evident.

On Vermilion lake the pyrite seems to be deposited (1) at the Vermilion mine, in a fissure along a brecciated contact between diabase and basalt-breccia, (2) on the island in the lake and on claim 779 in fissures in schistose quartz-porphyry, (3) on claim 778 at the contact between quartz-porphyry and greenstone and in association with a granite dike, (4) on Vermilion river, with vein quartz in iron formation, consisting of banded silica, magnetite and black slate. That the pyrite is later than the iron formation in the latter case and its origin is independent of it is seen from the fact that the black slate has been crushed and fragmented and the pyrite fills the cracks and often surrounds the fragments. It is probable that this rock was easily fractured and served as a favorable channel for the ascension of the pyrite-bearing solutions.

As to the source of the pyrite, nothing definite can be said, as there is no igneous rock associated with the deposits in such a way as to give definite evidence for regarding it as the source. However, on account of the frequent occurrence of smaller masses of pyrite where granite intrudes Keewatin schists in other regions, and of a large amount of pyrite in the veins and granite which is supposed to be the source of the vein material in the Sturgeon lake area, it is suggested that the granite in this area may have been the source. It is thought that the magma which furnished the material for the granite at the eastern border of the pyrite-bearing area may have been responsible for the fracture zone extending westward from the granite, and may have been the source of the sulphides which rose in solutions along the lines of fracture. The presence of the granite dikes in association with the small deposits in the eastern portion of the area, and the extent of the distribution of the deposits, seem to favor the granite as the source, because some source of extended distribution is necessary, and there is good reason to believe that the granite in subterranean form is much more widely distributed than surface exposures would indicate, although it occurs on the surface both east and west of the deposits.

Petrography

Basalt-Breccia

One of the most interesting rocks seen in the area was a basalt-breccia, occurring along the north side of the pyrite deposit at the mine. In the hand specimen this rock is made up of fragments, usually elongated and often splintery, or with circular cross-section. The fragments look very hard and almost cherty in some cases, but in others more like a fine-grained greenstone, and they can be found grading over into solid, fine-grained greenstone. The spaces between the fragments are filled with calcite and a little quartz. In places large crystals of feldspar, about three-quarters of an inch in diameter, with good cleavage faces and colorless to grayish brown may be seen. The arrangement of the schist around the crystals gives it a sort of augen structure.

In the thin section the angular fragments are found to consist almost entirely of uralite, zoisite and secondary quartz, these being the alteration products of basalt. The spaces are filled with calcite and a little quartz and pyrite. The feldspar is plagioclase, and from the presence in it of so much zoisite as a secondary product and the extinction angles on (010) it is identified as anorthite. The mineral shows some recrystallization, with fresher feldspar in parts of the crystal, and this is believed to represent a growth of the crystal by the addition of secondary material deposited under metamorphic action.

Iron Formation

Several specimens of banded silica and magnetite and silica and graphitic slates were taken. The black slates are frequently crushed, and have the pyrite arranged along the cracks and surrounding the fragments so as to show the later origin of the pyrite. The silica consists of small interlocking grains like chert which has been crystallized under metamorphic processes. Bands of magnetite frequently occur in the silica.

Epidote Granite

An attractive granite occurs along the railway track near Pelican lake. It is medium fine-grained, pink in color, with yellowish green specks of epidote. It forms many dikes in greenstone, as may be seen in the railway cuts, and frequently contains inclusions of greenstone and schist. In thin section it is found to contain orthoclase, a little microcline and albite, a little dirty green hornblende, considerable epidote and much quartz. The rock has been metamorphosed, as some parts are granulated and most, if not all, of the epidote appears to be secondary.

Other rocks of the region are altered greenstones and acid rocks, and a few of apparently sedimentary origin.

APPENDIX: REPORT ON THE TIP TOP COPPER MINE

BY E. S. MOORE

Introduction

A geological examination of the Tip Top Copper property was made during the latter part of the field season of 1910. This property includes locations K 62, 63, 64 and 65, but the last was the only one upon which any ore was observed and any development work done. My work was, therefore, confined to the investigation of the mine and its immediate vicinity.

The mine camps are situated on the east shore of Round lake, and the shafts a short distance to the east of it. This lake is reached by a walk or drive of 1¾ miles from Kashaboiwe station, on the Canadian Northern railway west of Port Arthur, to lake Shebandowan, followed by a nine-mile gasoline-launch trip on this lake and a walk of four miles between lake Shebandowan and Round lake. About the year 1902 a government wagon road was constructed from Kashaboiwe station, a distance of 8 miles, to Round lake, but this is not much in use at present, as no work is being done at the mine aside from clearing and cleaning up the property, although a watchman is kept constantly on the ground.

I wish to express my indebtedness to Colonel Ray of Port Arthur, owner of the mine, for his hospitality during my visit to the property.

History of the Mine

This property has been mentioned a number of times in the Bureau of Mines reports, the first references being by Coleman and Blue in Vol. V, 1895, p. 75. Since that time notes have been made by Professors W. G. Miller and W. L. Goodwin, and by Messrs Fraleck and Carter, and there has been considerable difference of opinion regarding the nature of the country rocks associated with the deposit.

A good deal of work has been done on the property, and although the shafts were full of water and could not be inspected at the time of my visit, Colonel Ray informed me that No. 2 shaft was 50 feet deep with a drift north 50 feet and one south 102 feet. Shaft No. 1 is 200 feet deep with drifting at 50-foot levels, and a drift runs west 60 feet and east 150 feet. A cross-cut also runs north 100 feet. Mine Inspector W. E. H. Carter states that in 1903, 4,000 tons of 8 per cent. ore were raised.

A small smelter was purchased and it was intended at one time to instal it, but the lack of transportation facilities and a fall in the price of copper are said to have been responsible for a cessation of mining operations.

Geological Relationships at the Mine

The accompanying sketch map (page 211) will indicate better than any description the geological relations at the mine. The greater portion of the rocks in this vicinity are greenstones, consisting of altered basic porphyries and fine grained diabase with green schists derived from these and similar rocks. These greenstones and schists lie as ridges on the north and south sides of the deposit and enclose it. Some of the schists penetrate the deposit in a way which makes their relations very uncertain and complex, and it is believed that these relations have been partly due to folding and partly to faulting, although no definite fault planes were observed. The general strike of the rocks varies from about 90° to 100°, being thus almost east and west.

Across the northwest corner of K65 and extending farther to the northwest there is a large mass of quartz-porphyry, or possibly altered rhyolite, which is believed to be later than the greenstones. The greenstones and quartz-porphyry are probably Keewatin in age.

After the quartz-porphyry was formed it is believed that a large mass of quartzite was laid down and a portion of it, about 250 feet wide and a quarter of a mile long, has been preserved from erosive agencies by being folded into a syncline in the schists. Concerning the determination of this rock as a quartzite, there has been much difference of opinion. Dr. Coleman speaks of the deposit as a fahlband, evidently considering the silica to be in the form of vein quartz[1], Professor Miller says that what has been called chalcedony appears to be very fine-grained aphanitic felsite or quartz-porphyry[2]; while Professor Goodwin calls it a quartzite[3].

Much of this rock looks like chalcedony, and from an examination of a number of thin sections and a study of the rock in the field the writer has concluded that it is a quartzite which has been greatly metamorphosed by processes which folded it and produced the green schists, and by the intrusion of quartz-porphyry dikes accompanied by hot solutions. So highly metamorphosed is the rock that the grains are in many cases intergrown as the crystals in a quartz vein, and vein-like streaks through it look like portions of the rock which have been taken into solution and precipitated in the form of vein quartz. That the determination of this rock is important is evident from the fact that the depth to which the rock extends will depend somewhat upon whether it is a fissure-filling or a sedimentary rock folded into the schists. It is probable that in the widest portion of the syncline the quartzite extends to a good depth, as the dip is at a high angle.

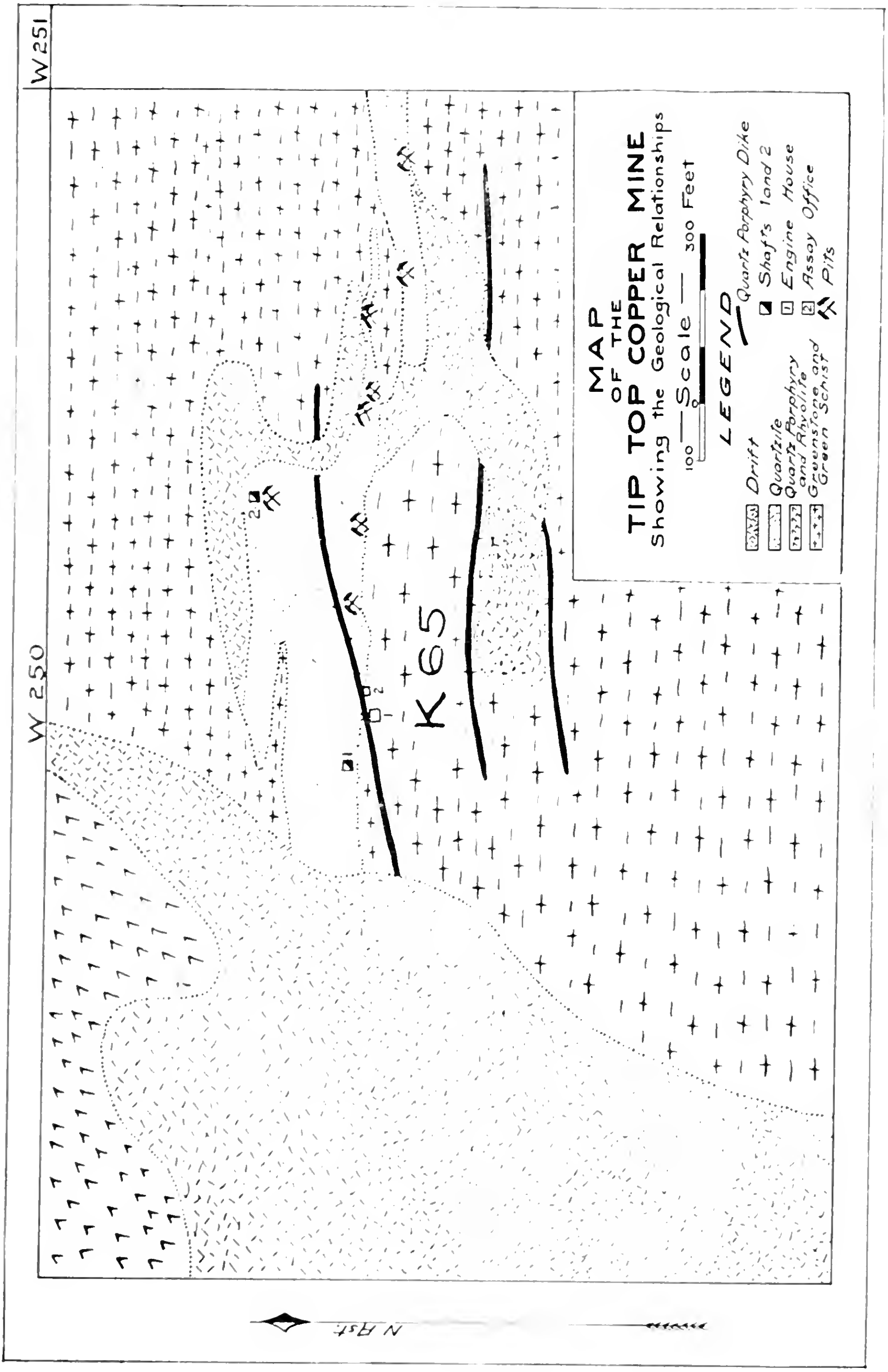
This quartzite is probably Huronian in age, and it has been intruded by some old quartz-porphyry dikes which are now almost altered to sericite schists. Still later than these old dikes are some comparatively fresh, flesh-colored, quartz-porphyry and felsitic dikes which are believed to have been responsible for the origin of the ore.

The ore occurs disseminated in these dikes and in the quartzite where it has been replaced near them, as well as along the contacts between quartzite and green schists and quartzite and sericite schist dikes.

Character, Occurrence and Origin of the Ore

Character of the ore:—The ore at the mine consists of chalcopyrite with small quantities of its alteration products, malachite, bornite and limonite. There is not much gossan to be seen. E. L. Fraleck's analyses of some of the gossan yielded iron 52 per cent., S. 0.45 per cent. Accompanying the chalcopyrite there is a great deal of iron pyrite and some pyrrhotite. The greenstones and the green schists of the vicinity as well as the quartzite, especially in local areas, carry considerable pyrite disseminated through them. The pyrite is much more common than the chalcopyrite in the greenstones and schists, the latter sulphide being confined to the quartz-porphyry dikes and quartzite or the contact zone in the schists. It is probable that much of the pyrite is

[1] Bur. Min., Vol. V. (1895), p. 75. [2] Ibid., Vol. XII. (1903), pp. 101-2. [3] Ibid., Vol. XIII. (1904), p. 56.


MAP OF THE TIP TOP COPPER MINE
Showing the Geological Relationships
Scale
100
0
300 Feet
LEGEND
Drift
Quartzite
Quartz Porphyry and Rhyolite
Greenstone and Green Schist
Quartz Porphyry Dike
Shafts 1 and 2
Engine House
Assay Office
Pits
W 251
W 250
K 65

of earlier age than the chalcopyrite, though large lenses of the former occur associated with the latter. In his report on Iron Pyrites in Ontario[4] Fraleck says that there are large masses of pyrite in this mine running 40 per cent. in S. and suitable for the manufacture of H_2SO_4, were it not for the cost of mining and shipping. Siderite is widely disseminated through the quartzite, especially along the cracks in the rock.

Besides the minerals mentioned, Mr. Goodwin states that a mineral carrying cobalt and which is probably smaltite, was found and also that the ore carries values in gold and silver[5]. In the same report W. E. H. Carter states that a steel-gray mineral containing 2 per cent. cobalt had been found. Coleman mentions a green silicate which was reported to contain nickel, but the analysis which he had made did not reveal any of that element[6].

The mineralized area is large, but workable ore is confined to local areas where in some cases large masses of ore are said to occur. The ore is, on the average, low grade, and while the writer was unable to investigate the ore bodies in the shafts, on account of the water not being pumped out, he believes that the geological conditions are favorable for the production of a considerable quantity of ore.

Occurrence:—The accompanying map shows that No. 1 shaft and most of the test pits, which are in the majority of cases located on the most promising portion of the deposit, occur in the quartzite, either near the contact between the schists or greenstones and the quartzite, or near the late quartz-porphyry dikes. In shafts 1 and 2 one of these dikes is encountered in the workings and bodies of ore occur near it. Smaller masses of disseminated ore occur along some of the older quartz-porphyry dikes which cut the quartzite, but which are now nearly altered to sericite schist. No strong ore body occurs immediately at the surface, though much disseminated sulphide is seen in the quartzite.

From the relationships enumerated, future development is warranted in the quartzite along the contacts between schists and quartzite, near the contact between the flesh-colored, quartz-porphyry dikes and the quartzite, and especially near the points where schists quartzite and quartz-porphyry dikes converge.

Origin of the ore:—It is believed that the ore is a replacement of the quartzite. It is also thought that the ore had its source in the magma which was the parent of the quartz-porphyry dikes, and that when fissures for the reception of the dike material were opened, the ore in hot solutions accompanied the igneous rock and replaced the quartzite near the dikes, and also along the contact between the quartzite and other rocks where lines of weakness permitted ascension of the hot solutions. The quartzite is the only rock of the group capable of replacement to any extent, and that is why the ore is found restricted almost entirely to this rock.

The reasons for the opinions expressed above lie in the facts that the chalcopyrite is disseminated in the quartz-porphyry, apparently as a pyrogenetic mineral. The ore occurs in largest masses, so far as seen, in close proximity to these dikes, and where it occurs away from their immediate vicinity there is nothing opposed to the supposition that they are the source of the ore. A number of cases could be cited from the west, where deposits are well understood, which show copper deposits in replaceable rocks and associated with quartz-porphyry dikes, and in the case of quartzite, it would be replaced readily enough by very hot solutions. It is interesting to see how often quartz-porphyry, especially in the form of dikes, is associated with copper ores.

Petrography of the Rocks at the Mine

Along the north side of the quartzite between shafts 1 and 2 there is an interesting green schist in which there are numerous rounded, blue, opalescent quartz grains. In thin section the rock is seen to be made up of small interlocking quartz grains, a little pyrite, actinolite and these blue bodies of quartz. There appears to be a striking

[4] Bur. Min., Vol. XVI. (1907), p. 173.
[5] Bur. Min. Vol. XIII. (1904), p. 56.
[6] Ibid., Vol. V. (1895), p. 75.

difference between the number of mineral inclusions in the large blue grains and the small colorless grains. The inclusions look like iron oxide, and some of them may be recognized as hematite, but many of them are too small for identification. It is probable that the blue color is due to many of these inclusions being so small that they are in diameter less than one half a wave length of light and they are thus able to refract the light sufficiently to cause the color. As to the opalescent character it is thought that it must be due to some particular conditions of temperature under which the mineral cooled—perhaps to sudden cooling. In work in other regions these blue quartz grains have frequently been found in contact metamorphic zones, and in some places the relations to the contact have been so marked that one could often determine its proximity by these blue quartz grains. The rounded character of the mineral might be due to the fact that in rapid cooling to a crypto-crystalline condition the crystallizing force would not be so strong as in a phanerocrystalline variety of silica, and the mineral would take a rounded instead of a euhedral form.

In thin sections of the quartzite the features most marked are the interlocking of many of the grains, due to recrystallization, and the disseminated siderite and sulphides.

A thin section of diabase from the hill to the south of the deposit shows the feldspars much altered to zoisite and kaolin, and the pyroxene to uralite and chlorite. A great deal of quartz is present, but it may be secondary, having been derived partly from the alteration of the feldspars and partly by infiltration in solutions from without.

IRON AND LIGNITE IN THE MATTAGAMI BASIN

BY M. B. BAKER

In April 1910 I was instructed by the Deputy Minister of Mines to proceed with a party to the lower Mattagami river, and investigate the newly-discovered "coal" deposits reported as occuring there. After completing this work, I was to inspect an iron occurence farther down stream, which was then being developed by Mr. Foster Shields of Sudbury; and further, to examine the pre-Cambrian rocks between these areas and the Grand Trunk Pacific railway if time would permit. Accordingly I met my assistants in Cochrane on May 12th. My party consisted of Messrs W. D. Harding of Oshawa, McKay Meikle of Kingston, and Archie Mitchell of Toronto, who one and all entered with spirit and interest upon the work of the summer

The route from the Grand Trunk Pacific railway to the Iron and Lignite areas is necessarily by canoe, and as these routes are likely to be much used in the future, a detailed description of them may be useful to travellers, who are also referred to the map accompanying this report A glance at this will show that the area under discussion may be reached from three different starting points on the Grand Trunk Pacific, as three large rivers, the Mattagami, the Ground Hog, and the Kapuskasing, converge to form the lower Mattagami. These will be described in the order named.

Mattagami River

The Mattagami is about two hundred yards in width where crossed by the railway, and flows with a fast current for about two and a half miles to Smooth Rock Falls (Fig. 1). These are passed on the east shore by a portage of two hundred and fifty yards. For the next eight miles there is fast water, and a few small ripples, but nothing that cannot safely be traversed even in small canoes. At the end of this distance is Fish Rapids, which must be passed on the east side by a short portage of one hundred and fifty yards. The next ten miles are marked by strong currents, but no rapids to speak of. Poplar Rapids is reached, a long, crooked rapid at the mouth of Poplar Rapids river. These rapids, about one mile and a half in length, can be safely run even in ordinary canoes by keeping to the east shore. About half way down canoes cross to the west shore and follow the current. There is no portage, care only is necessary. For the next ten miles the water is quiet, as the river widens out for practically the whole of this distance, but at the end of this stretch is Cypress falls, which takes two plunges, in all about twenty feet (Fig. 2). At the foot of the upper and smaller fall is a deep circular basin, and large canoes may run this portion with safety by keeping close to the west bank. The portage at the north side of the basin should be taken, thereby saving nearly half a mile of the carry. Small canoes should be portaged from the head of the smaller fall on the west bank around the basin to the foot of the higher fall, making a portage of about half a mile all told.

From the foot of the Cypress falls, the river is faster again, but there is no difficulty even in small canoes. About three miles of fast water bring the traveller to the mouth of Ground Hog river, which enters from the southwest. As this river will probably be more used than the Mattagami, the route will be described from the railway to the junction with Mattagami river.

Ground Hog River

The Grand Trunk Pacific railway crosses the Ground Hog river about eighteen miles west of Mattagami crossing, and the river here presents a splendid appearance (Fig. 3). It is wide and deep, and with some islands within half a mile of the bridge the whole forms a pleasing view. This river affords a very much better route than the Mattagami. There are only four portages, and these are all short and very good ones. The remainder of the river is easily navigated in any canoe. From the railway for five and a half miles down the river there is a fair current, after which a small rapid is reached, easily run in

Fig. 1. Smooth Rock Falls, Mattagami river.

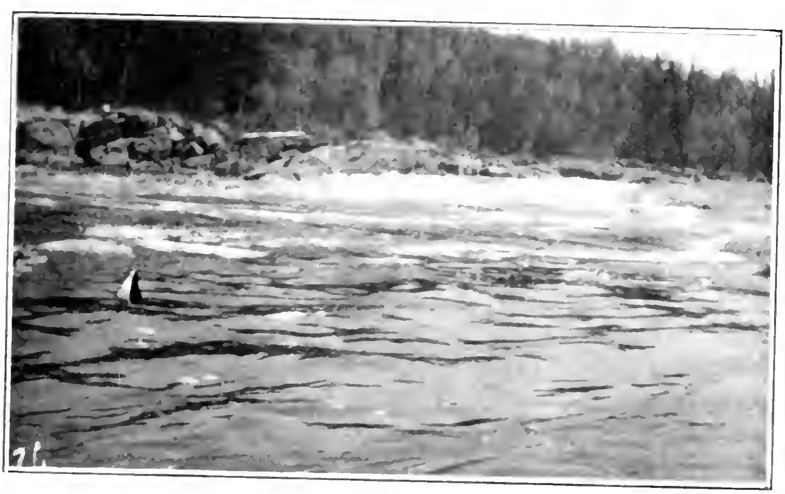


Fig. 2. Cypress Falls, Mattagami river.

midstream. The next three miles is free of obstruction as far as Dixon rapids, which are very rough, but are overcome by a good portage on the east bank, about three hundred yards long. About one and a half miles of easy water follows, then a group of islands with fast water flowing about them, but by keeping to the east shore these are easily passed. Two and a half miles more of gentle current brings in view Hamilton rapids, which are passed by a two-hundred-yards portage on the east shore. Slightly over two miles farther is met the next break in navigation. Here there is a rapid with a chute at the foot of it. This is called La Duke falls, and is passed on the west shore by a portage of three hundred and fifty yards. For the next three miles the water is faster, but there is no difficulty whatever in travelling until Whist falls is reached. This fall is short, and is passed by a portage of a hundred and fifty yards on the west shore. From here to the junction with the Mattagami, a distance of about ten miles, the Ground Hog becomes gradually broader and shallower, so that in the summer months the water is very low and very fast. This makes travelling, in anything larger than a seventeen foot canoe, rather difficult, as the water is too shallow to float a loaded canoe. There are no more rapids nor portages, however, and except in the low water of August, this is a much preferable route to the Mattagami. Having now reached the Mattagami, its description will be continued to the entrance to the Kapuskasing river.

The Mattagami flows with a strong current from the mouth of the Ground Hog for four and a half miles. Then a rough rapid is reached around an island, which, in low water, becomes a point. This is called Shore rapids, and the portage is on the island, about one hundred and fifty yards in length. In low water the rapid can be safely run on the east side of the island. A little less than two miles from this island is the entrance of the Kapuskasing, with no further breaks in navigation between.

Kapuskasing River

The Kapuskasing affords the best and easiest route, especially in the summer months, for both the others get so low that they are too shallow in many places for even the smaller canoes. The railway crosses the Kapuskasing at White Spruce falls (Fig. 4), as they are called in the older reports of the Bureau of Mines. An island about the middle of the river forms an excellent opportunity for bridging, and this has been taken advantage of by the builders of the railway. About a mile below the bridge is a small rapid which can be run in larger canoes, but a short lift over a point on the east shore is the safer method for small canoes. Three-quarters of a mile farther down stream is another small rapid, with a portage of fifty yards on the west shore, but this can also be run safely in larger canoes. About three-quarters of a mile below this is a rough fall, called Sturgeon falls (Fig. 5), because it is alleged that the sturgeon never go above this point (see Fig. 6). A short portage across a point into a cove on the east shore must be used here. This is the last portage that need be made on the river, although there are four other rapids that require some care in running. The first of these is about twelve miles below Sturgeon falls, where the river narrows and flows through a narrow channel, but this is in reality only very fast water which can easily be run in a small canoe. Two miles of easy current brings one to the mouth of Lost river, which enters from the west, and is navigable to the railway by a very circuitous route of some thirty miles. Immediately below the entrance of Lost river is the second rapid, but this can also be run on the west side. There is no further trouble for sixteen miles, where occurs another rapid, which is rather rough. It can be run in larger canoes, and lined down in smaller canoes, or a short lift over a point on the east shore may be used. It is about seven miles from here to the mouth of the river, where there is a long rough rapid, which can be run even in small canoes by keeping close to the east shore. The foot of this rapid effects a junction with a broad stretch of the Mattagami river, which will now be followed to the point where it empties into the Moose river.

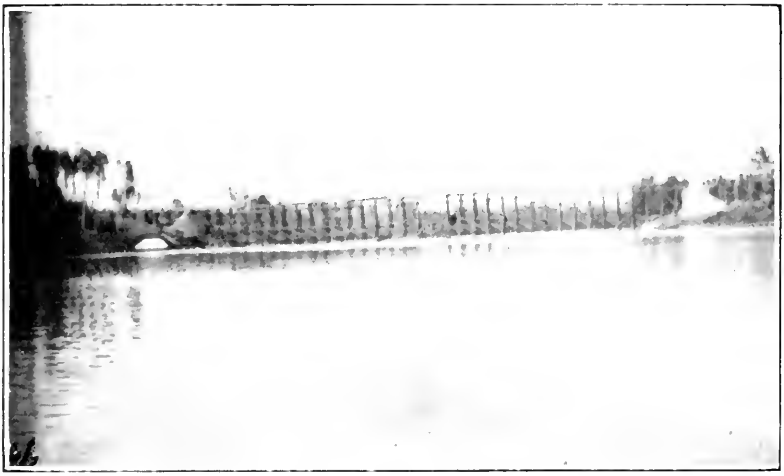


Fig. 3.—Ground Hog river at G.T.P. railway crossing.

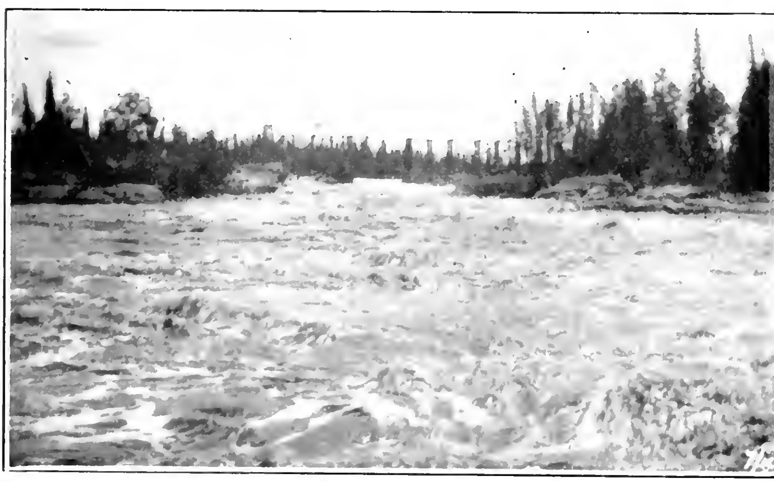


Fig. 4.—White Spruce falls, Kapuskasing river.

The Lower Mattagami River

Below the entrance of the Kapuskasing there is splendid travelling for about nine miles to Devil's rapid, a very rough piece of water (Fig. 7), with a chute at the foot (Fig. 8). There is a double portage on the east shore. The first starts at the head of the rapid, and is the safer one to take, but a second portage starts at a small eddy below the first short stretch of rapids, and joins the longer portage about one-third of the way across. This reduces the portage to about a third of a mile, whereas the whole portage would be about half a mile. The lower end of this portage leads to a broad lake-like expanse of the river. A sandy island has been formed at the foot of the rapids. Canoes pass on the inside channel east of this island, and have fast but safe water for about eight miles, as far as a group of islands at the head of a long, rough rapid, with a chute near the foot. This rapid is the first of a series that in the next ten miles drop a total of four hundred and twenty-five feet, indicating the roughest part of the river (Fig. 9). The Little Long portage by which this first rapid is passed is on the west shore and is difficult to find. Keeping to the west shore, two islands are passed to the

Fig. 5. Sturgeon Falls, Kapuskasing river.

very head of the rapids, where there is a blind channel into the west bank. This is followed for a hundred yards where it turns sharply to the north. At the northern end of this arm is the portage, one and a half miles in length, but a very good one. The other end of the portage comes out at a sharp notch in the rocks. The water here is very fast, but is safe with ordinary care. On leaving the portage two islands are passed by the western channel, then the river is crossed to the east channel, between a large island and the main shore, where there is the head of a short but stiff rapid. A short lift over the point just above the draw is the safest method for passing this. Another mile of fast water is succeeded by Wagadawing rapids, which is in reality two rapids; the upper and shorter one of which may be run close to the west bank to an eddy, from which a second portage joins the longer one from the head of the rapids. This portage is half a mile long, while that from the lower eddy is not more than three hundred and fifty yards.

About half a mile below Wagadawing rapids is a short, rough rapid, which can be lined down, on the west bank in high water, or passed by a lift over the point of rock in low water. This rapid is rough and not safe for any but large canoes. Another half mile brings us to Smoky falls, so named because the spray of the falls hangs continually as a cloud over the canyon. This is one of the most beautiful gorges and falls of the north country (Fig. 10); the water divides around an island at the very head of the

Fig. 6.—Sturgeon taken in Kapuskasing river.

Fig. 7.—Devil's rapid, upper stretch, Lower Mattagami river.

falls, and drops vertically for twenty-five feet, then boils through a narrow canyon, forming a most beautiful picture (see Fig. 11).

A portage of about five-eighths of a mile is on the west shore, just oppsite the head of the island

We now cross the river to the east shore, and about half a mile below Smoky falls come to a rapid at a sharp point. This can be lined down, or a short lift across the point to a cove saves time and possibly danger. Half a mile farther there is another rough rapid, with a portage of three hundred yards across the point on the east shore. The east bank is then followed around a bay-like enlargement of the river, for about half a mile, and at the very head of the rough rapids (Fig. 12), and at the foot of a high clay bank, comes the Long portage, four and a half miles. The portage leads up this clay bank to the top, about seventy feet, then strikes off to the north, and after a mile of excellent going a small lake is reached, which may be used or not, as the traveller wishes. The next two and a half miles are over a sandy plateau, and the portage is in excellent shape, but the last mile is not so good, there being more muskeg and marshy land to cover. At the north end of the portage, another steep clay hill is descended to the river. This is the last portage, and one may travel from here to Moose Factory on James bay without leaving the canoes. Much fast water will be encountered, but it is nowhere dangerous, except possibly Grand rapids, some twenty-five miles below the Long portage.

Seven miles below Long portage is the Big Bend of the Mattagami river. Just above this bend the newly discovered lignite is located, which was primarily the object of this expedition. The deposits are described later in this report. About eighteen miles down stream from the lignite is the head of Grand rapids, a long fast rapid which extends for two miles. It can be safely run on either side, but the east shore is preferable. The rapid is over a shelving series of limestone beds (see Fig. 13), so it is not rough, but is a series of small steps. This is the only place that demands care in passing. The remainder of the Mattagami to its junction with the Moose river is shallow, broad, and very fast (Fig. 14), but is perfectly safe. The same may be said of this latter river to the Hudson bay post on James bay. Grand rapids is an important point on the Mattagami, for here are found the iron ores, which it was also my duty to examine, and which are described later in this report.

Geology

Ever since the emergence of the Laurentian plateau from the Archean sea, a height of land appears to have been maintained between the Great Lakes and the basin of Hudson Bay. Within this basin a series of later sediments, including Paleozoic and Pleistocene accumulations, has been deposited. A similar but more extended series has been laid on the Great Lakes flank of this old barrier. The Hudson Bay basin therefore presents a well-marked geographical, as well as geological basin, bounded by a distinct rim of pre-Cambrian crystalline and metamorphic rocks. This latter area presents a somewhat rough undulting surface, dotted by many small lakes, marshes, swamps and muskegs, and has a steep grade towards James Bay from all sides, as is clearly shown by the convergence of the many splendid rivers which flow down its slopes. The rapid descent is most pronounced where the pre-Cambrian approaches the margin of the Paleozoic sedimentary area. As a consequence, the "long portages" on all these rivers occur at these points. Once the sedimentary area is reached the flow is very rapid but gradual all the way to Hudson bay, so that no portages are necessary for practically the whole journey.

Laurentian Plateau

The Laurentian plateau in northern Ontario is commonly styled a rocky country, but several seasons of field work in that part of the province have led to the conviction that the amount of rock exposed is very much less than is commonly supposed. In fact, except at rapids or falls, where rivers have cut rather deep gorges in the drift, there is scarcely an outcrop of rock to be seen in the country, so that it is essentially

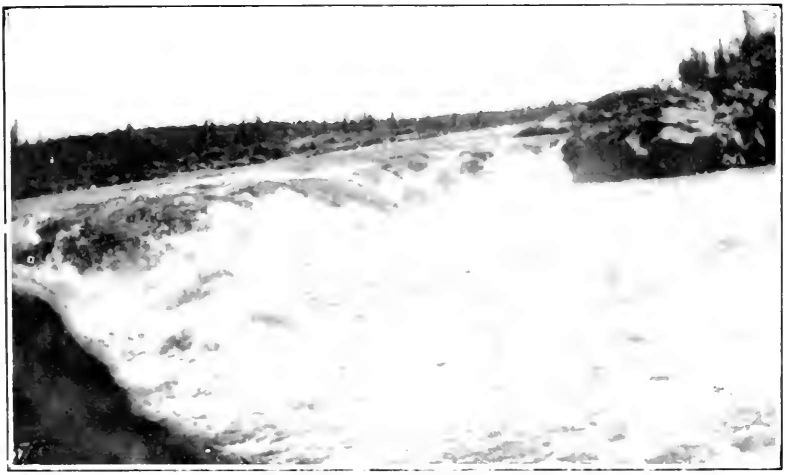


Fig. 8.—Foot of Devil's rapid, Lower Mattagami river.

Fig. 9. -Rough water on Lower Mattagami river.

Fig. 10.—Smoky falls, Lower Mattagami river.

Fig. 11.—Foot of Smoky falls, Lower Mattagami river.

an agricultural one. The Paleozoic area has a flatness that is monotonous, and is perhaps too wet and flat to admit of sufficient drainage for agricultural purposes. Moreover the upper portion of this area is sand and is quite unsuited for agriculture. The suitability of the coastal plain for farming will be discussed in greater detail when dealing with the Recent deposits.

This report is primarily intended to discuss the lignite and iron deposits, but in order to do this, it is desirable to describe briefly the stratigraphy of the area, since this will aid much in accounting for the economic occurrences of the district.

Stratigraphical Record

RECENT

(*Erosion unconformity*)

PLEISTOCENE { Glacial
Inter-glacial, lignite series
Glacial

(*Erosion unconformity*)

PALEOZOIC

Corniferous

(*Erosion unconformity*)

UPPER HURONIAN

(*Erosion unconformity*)

POST-MIDDLE HURONIAN

Diabase.

(*Intrusive contact*)

LAURENTIAN

The Laurentian Rocks

The reader is reminded that the area under examination lies north of the Grand Trunk Pacific railway, and here no Keewatin rocks were seen. They do come in, however, a short distance directly south of the railway. The oldest formation seen in this area therefore is the Laurentian. It consists almost entirely of typical pink granite gneiss, but varies in many places to a hornblende granite, or to a mica granite. The rock for the most part is coarse grained, and consists chiefly of three minerals, quartz, orthoclase, and biotite mica, with various accessory minerals, the chief of which is microcline. All the feldspar is more or less decomposed, so that the weathered surface of the rock has a distinct kaolinic appearance. Practically the whole of the pre-Cambrian area north of the railway is this pink gneiss, of very uniform character throughout.

Cutting this in all directions is a series of diabase dikes, many of which are indicated on the map which accompanies this report. These dikes are the typical post-Middle Huronian diabase of the north country, and do not seem to differ in any way from the diabases of other portions of northern Ontario. They vary in width from mere stringers up to 250 feet; examples of the latter occur at the foot of The Long Portage (Fig. 15), and again in the channel of Wagadawing rapids. They are dark gray, medium to fine grained diabase, composed of laths of fresh labradorite feldspar, set in a ground mass of augite, which is partly in felt-like aggregates resembling uralite, and partly in larger well defined crystals and grains. A little original quartz is to be seen in thin sections, and often in the hand specimens, together with accessory pyrite and magnetite. At several places, calcite veins were found up to three inches in width cutting this diabase, but they did not show any of the silver, nickel or cobalt minerals so characteristic of similar occurrences in the Gowganda or Elk Lake areas.

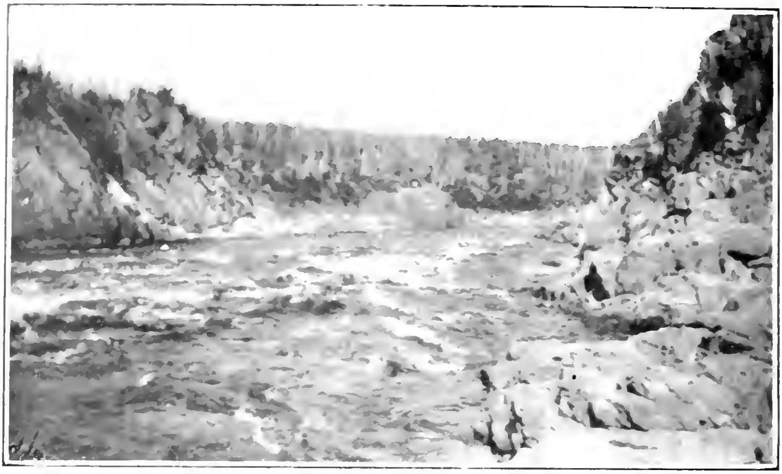


Fig. 19.—Rough stretch of Lower Mattagami river, below Smoky falls.

Fig. [illegible].—Grand rapids, Mattagami river.

Upper Huronian

As a fringe along the edge of the sedimentary basin is a formation which has been placed as Upper Huronian or Animikie in age. There are but few outcrops, and these only along the border. It is made up of a rich, dense brown siderite, which shows a banded structure in places. The composition is very pure, as is shown by the following analysis:

—	Fe	CaO	MgO	CO_2	Al_2O_3	MnO	Sp.G.
Siderite from Grand Rapids Mattagami River	43.27	1.47	0.91	34.94	2.31	1.74	3.63

Fig. 11. Mattagami river, above its junction with the Moose.

Associated with this siderite is a fine grained quartz conglomerate, shading in places to quartzite. The pebbles of this conglomerate are for the most part quartz, which apparently have been derived from the Laurentian, and cemented by a siderite. This Animikie siderite is an important formation, for it is probably the source of the limonite to be described later.

J. M. Bell found a similar siderite on the Opazatika river in 1904, for he says:[1] "Apparently the carbonates have resulted from the direct precipitation from a sea-water rich in iron, magnesia and lime, on the surface of the upturned gneissic beds cut by dikes of pegmatite. . . . No fossils are found within the beds and their age is in consequence a matter of conjecture, but from their lithological resemblance to the iron-bearing calcareous magnesium rocks of the Mesabi Range on Lake Superior, they have tentatively been classed as Huronian." But he immediately adds, "though, as a matter of fact, they may be more correctly correlated with the ferruginous carbonates of the Devonian of the coastal plain."

At the head of Grand Rapids, siderite, sideritic conglomerate, and quartzite were found all in situ, and by digging out one outcrop a photograph was obtained (see Fig. 16). By wading into the water at the head of the rapids the siderite and conglomerate

[1]Bur. Min., Vol. XIII. (1904), p. 152.

could be quite easily traced across the bed of the river. Chemical analyses of this rock together with that of the Helen mine siderite, and of a typical piece of Animikie siderite from the Mesabi Range are given below for comparison.

Locality.	Fe	CaO	MgO	CO_2	Al_2O_3	MnO	SiO_2	Sp.G.
Siderite from Grand Rapids	43.27	1.47	0.91	34.94	2.31	1.74	1.40	3.63
Typical Animikie siderite, Loc. 5, Township McGregor	28.97	3.59	6.20	29.06	5.41	3.50	22.87	3.40
Siderite from Helen Mine	35.69	1.03	7.53	37.18	3.92	......	......	3.72

Fig. 15.—Diabase dikes, foot of the Long Portage.

That these siderites are silicious sediments of pre-Cambrian age seems clear from the following features: The lack of fossils and of bedding, their compact structure, their occurrence as a fringe along the edge of the Paleozoic and next to the Laurentian floor, their lithological and chemical character, and the massive texture which seems to correlate them with the Animikie iron formation of the Lake Superior basin,—a corresponding basin on the south side of the same Archean axis.

Whether they are Animikie or not, however, does not really signify. There is no doubt that they are pre-Cambrian, and the significant fact is that on the north side of the old Archean axis Proterozoic sediments are laid down, just as they are on the southern side. If they ever covered the axis itself, they have been removed by erosion, but this is doubtful, as some few outliers would surely have been left. Since rocks of a similar character are reported by Dr. Lowe,[2] and by Dr. C. K. Leith,[3] it seems fair to presume that there is a considerable area of these sediments in this basin, and if so it is also reasonable that with better opportunities for exploration, economic deposits similar in kind, if not in extent, to those in the Lake Superior basin, may be hopefully looked for in the future.

Paleozoic

Lying unconformably on the pre-Cambrian is the Silurian and Devonian limestone in practically horizontal, undisturbed condition, although in a few places subsequent folding has produced local anticlines and synclines. The general dip of the series is to

[2]Geo. Sur., Can., Vol. XIII., 1903. [3]Economic Geology, Vol. V., p. 227.

the southeast. The exposures are in cliffs of earthy, drab to dark, bituminous limestone. The cliffs are much dissected by enlarged joint-planes through dissolution (see Fig. 37), and rise twenty to thirty-five feet abruptly from the water. Fossils are quite abundant in these rocks, a number of which were collected and brought back. These have been identified by Dr. C. R. Stauffer, Paleontologist at the School of Mining, Kingston, who reports as follows:

The collection of fossils brought back from Mattagami river by Professor M. B. Baker, proves the presence of both the Devonian and Silurian limestone in that locality. In addition to many of the Devonian forms reported by Professor W. A. Parks[4] from the Kwataboahegan river, such as:

Favosites gibsoni, Parks.
Phillipsastrea verneuli, E. and H.
Zaphrentis gigantea, Lesueur.
Atrypa reticularis, Linnæus.
Meristella nasuta, Conrad.
Spirifer divaricatus, Hall
Conocardium cuneus, Conrad.
Loxonema robusta, Hall.
Dalmanites (Chasmops) anchiops, Green.
Etc., etc.

Fig. 16. Animikie siderite.

the collection also contains specimens of the following Devonian forms:

Favosites emmonsi, Rominger.
Favosites polymorphus, Goldfus.
Henderella canadensis, Nicholson.
Atrypa impressa, Hall.
Stropheodonta hemispherica, Hall.
Modiomorpha mytiliodes, Conrad.
Pleurotomaria lucina, Hall.
Gyroceras trivolva, Conrad.
Orthoceras zeus, Hall.
Aspidichthys notabilis, Whiteaves.
Etc.

Except Favosites gibsoni, Atrypa impressa, and Aspidichthys notabilis, it will be noted that these are all typical Onondaga (Corniferous) limestone forms, such as are found in many of the outcrops of southwestern Ontario as well as in the adjoining regions of the United States.

[4]Bur. Min., Vol. XIII (1904), Pt. I., pp. 180-191; plates I.-VIII.

Favosites gibsoni is an abundant coral. One specimen shows in addition to the characters given to the species in the original description, a decided tendency to branch, three or four small knob-like projections extend out from one side and the broken end has the base of a projection which is most likely a true branch. A close examination of the weathered surface shows a remarkable arrangement of the corallites. About one in twelve to fifteen is slightly larger than the others, and the ordinary-sized individuals are arranged in circles of six to nine around the larger ones, while the inter-spaces thus left are also filled with smaller ones. This latter feature is scarcely observable on the unweathered surface, and every other feature tallies so well with the species to which this particular specimen has been referred, that it can hardly be considered a distinct species.

Atrypa impressa is a form which has been reported from the basal portion of the Middle Devonian of New York and Michigan only. Hall considered it a typical Scholarie grit form. The specimens in this collection are well preserved and the pedicle valve shows no sinus, while the brachial valve has the mesial elevation marking the front or upper half of the length, is flattened, evenly furrowed on top, and the front is cut off squarely. It is undoubtedly the species described in the New York reports.

Aspidichthys notabilis? The fish plate, doubtfully referred to this form, is very fragmentary, but has the thickness which Hall referred to in describing A. clavatus,

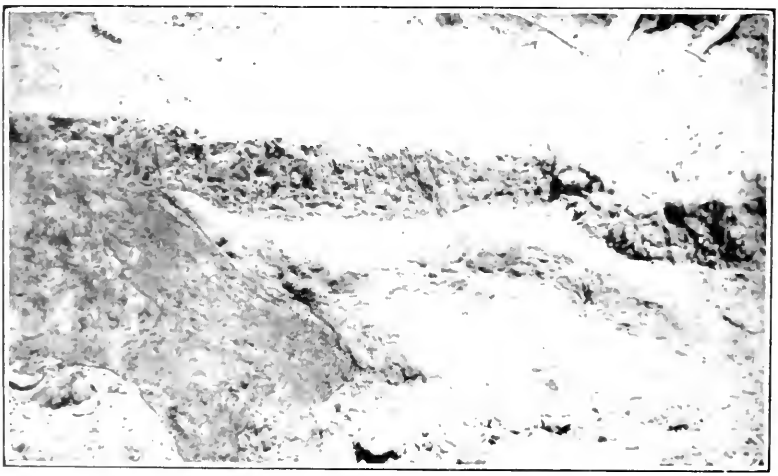


Fig. 17.—Irregular folds in lignite series.

and the characteristic coarse tuberculation. Robert Bell[5] brought back from the James Bay region a number of fragmentary plates which Whiteaves referred to Macropetalichthys rapheidolabis. The interesting point in regard to the plate here under discussion is that it represents an entirely different form, and thus proves the existence of another one of the great Devonian fishes in that northern Paleozoic sea.

Every collection of fossils brought back from the James Bay region increases the list of common Middle Devonian species occurring there. The Corals, Cephalopods and Fishes are believed to be European immigrants into the great interior sea (Eastern Continental Sea of Williams) of North American Devonian time.[6] The importance of these elements in this northern Ontario region not only piles up evidence in favor of the supposition that those formations were once an integral part of the great, Middle Devonian deposits to the south, but suggests the route by which these forms reached the inner portion of that ancient Mediterranean sea. Only one Silurian fossil, Calymene niagarensis, was brought back in this collection. It was collected in a loose block from the bed of the Mattagami river and probably proves the occurrence of the Niagara limestone somewhere in that neighborhood.

Pleistocene

At the close of the Corniferous the sea must have retreated to the northeast, for there is no further sedimentation on this area until Pleistocene times, which show

[5] Geo. Sur., Can., Rep. Prog., 1875-76 (1877), pp. 319, 320.
[6] H. S. Williams, Am. Jour. Sci., 3rd series, Vol. XXXV., 1888, pp. 51 59.

Fig. 18. Boulders of lignite in drift.

Fig. 19. Typical Saugeen clay.

at least two glacial epochs, with a very long inter-glacial period during which the lignite series was formed. The lower drift is made up of clay, sand, and boulders of all sizes, for the most part of limestone rock which shows the typical glacial character; the whole being a typical glacial drift.

This is followed by an inter-glacial lignite series, composed of a lead-blue clay, arenaceous shale, lignitic clay and lignite itself. The entire area is not of even thickness, but is apparently from twenty to fifty feet. The inter-glacial beds suffered tremendous erosion from the ice of a later glacial age, which served to crumple, gouge, and plough up the lignite series in many places into irregular folds (see Fig. 17). This later glacier deposited a thick layer of dense boulder-clay containing many rounded and scoured pieces of lignite, which is a proof that glaciation not only followed the deposition of the lignite series, but that it was sufficiently later to allow for the formation of the lignite itself (Fig. 18).

Fig. 20. -Bank of Saugeen clay.

The Upper Clays

The uppermost portion of this last glacial drift passes into typical Saugeen clay (Fig. 19), of which the popularly called Clay Belt of northern Ontario is largely made up. The Saugeen clay forms great banks in most of northern Ontario (see Fig. 20). It is composed of alternating layers of very fat clay, with layers of find sand or silt, the interlamination being very pronounced (see Fig. 21), and so characteristic of Saugeen clay that the latter is readily identified anywhere. The Saugeen clay forms the uppermost portion of the last Glacial series, and the writer has suggested[7] that it owes its origin to depositions about the ice margin during the retreat of the sheet. During the summer or warmer season the increased flow of water from the ice-front would carry the clay farther out and drop the sand nearer to the edge. Then during the winter or colder season the decreased flow of water would drop clay on top of the last layer of sand. This process would be repeated year after year, and the accumulation would be carried gradually farther and farther north. Every two layers would represent the accumulation for one year, thus forming a possible means of estimating roughly the duration of this stage of the ice retreat.

The layers of clay and sand are usually about half an inch in thickness, but they occasionally ran up to three inches (see Fig. 20), when the thick layers are at the bottom and the thinner ones occur as we ascend the bank. The total thickness of Saugeen clay would be difficult to estimate. The deepest cutting seen was on the

[7]Bur. Min., Vol. XV. (1906), Part II.

Fig. 21.—Saugeen clay along railway near the shore of Lake Temiskaming, between Haileybury and New Liskeard.

Fig. 22.—Saugeen clay, showing boulders.

railway just east of the Ground Hog river, where a Saugeen bank twenty-six feet deep occurs. There are occasional glacial boulders found in this clay (see Fig. 22), and these are attributed to droppings from floating ice.

When the Saugeen clay is exposed to the weather the clay layers soon "slake" down and mix with the sand to form excellent clay loam, and thus constituting an excellent soil for agricultural purposes. It can therefore be seen why the Clay Belt is forming such an attractive area for settlement now that transportation is established through the Grand Trunk Pacific railway and the Temiskaming and Northern Ontario railway.

Recent Deposits

At the close of this last glacial retreat the sea must have advanced once more over the Moose Basin to approximately the pre-Cambrian boundary line, for there is found everywhere as the uppermost layer of loose material, sand and silt varying from two feet near the rim of the basin, to fifteen feet near Moose Factory. These are stratified marine sands, as shown by the presence of shells of many representives still living in James and Hudson Bay. A considerable number of these were collected and have been identified by Dr. Stauffer as follows:

Fig. 23. Testing lignite deposit with auger.

Marine Forms.

Pelecypods:
- Cardium islandicum, Linnæus.
- Macoma fusus, Say.
- Macomus proxima, Gray.
- Mya arenaria, Linnæus.
- Mya truncata, Linnæus.
- Saxicava artica, Linnæus.
- Saxicava rugosa, Linnæus.

Gastropoda:
- Fusus ventricosus, Gray.

Land and Fresh Water Forms.

Gastropoda:
- Amnicola porata, Say.
- Helix striatella, Anthony.
- Limnæus elodes, Say.
- Limnæus pallida, Adams.
- Limnæus umbilicata, Adams.
- Physa ancillaria, Say.
- Planorbis bicarinata, Say.
- Succinea obliqua, Say.
- Volvata tricarinata, Say.

These forms have also been reported in part from the post-Pleistocene deposits of the Ottawa valley, in part from the St. Lawrence valley, and from the deposits surrounding Lake Champlain, and they all belong to living species. The uppermost layer of sand which covers the Paleozoic sedimentary area renders this part of the basin unfit for agriculture. It forms a great flat plain which is almost entirely muskeg covered, and with the exception of the sphagnum moss supports little other growth. It is like a great prairie of moss and peat, with only a few scattered scrubby spruce trees upon it. In this connection may be summarized Mr. E. B. Borron's observations made after his examination of this area in 1890:[8]

In the flat country south of James bay underlaid by the Devonian limestone there are three classes of agricultural or pastoral land. (1) The strip immediately adjacent to the waters of James Bay, from a quarter of a mile to four miles in width, on which there is naturally fine pasture, and much marsh hay. A large number of cattle could be supported on this strip. (2) The low lying bottoms, points, and islands of alluvial soil found at intervals on the rivers in the territory. This land is good, but generally flooded in the spring, and while of considerable extent in the aggregate rarely occurs in blocks of sufficient size to form a large settlement. (3) A narrow strip along the margin of rivers varying from a quarter to a half mile back from the river. The whole country from the Abitibi on the east to the Albany on the west, and extending many miles inland to James Bay, is a vast level clay plain, overlaid almost everywhere by peat-bogs of very extraordinary extent.

The peat mosses described by Mr. Borron are estimated by him to occupy ten thousand square miles. While undoubtedly detracting from the agricultural capabilities of this district very materially, these great peat beds have a value of their own. It is not improbable that in the absence of a good quality of coal, prepared and pressed peat-fuel may come largely into use in Ontario, and if means of transportation are afforded, an inexhaustible source of supply would be opened up in this northern territory. Recent improvements of manufacture give ground for hope that we may soon be put in possession of a really efficient and economic fuel produced from peat. The value of peat as a deodorizer is also coming to be recognized, and in disposing of sewage and waste-matter it finds much employment in the cities and towns of continental Europe. In the form of moss-litter it is used with great success as bedding for stock, owing to its capacity, when dry, of absorbing as much as twenty-five times its own weight of moisture. When its use in stables is ended it is in condition to be employed as a fertilizer of the highest value. Peat also provides raw material for textile fabrics, and is employed as a preservative packing for fruit and perishable articles.[9]

It is estimated that the edge of this basin at the long portage on the Mattagami river is now three hundred feet above James Bay, so that there has been a recession of the sea to that extent since these most recent deposits were laid down, and the recession is still in progress.

[8]Rep. on the Basin of Moose River, p. 16.
[9]For a fuller account of peat deposits in Ontario and elsewhere, and their utilization for fuel or other purposes see Bulletin No. 1, Department of Mines, G.S.C.; also Peat Fuel; Its Manufacture and Use, Bur. Min., Vol. XII., 1903.

Lignite

Lignite has long been known to exist in the Moose River basin of northern Ontario, having been reported on almost every river of the James Bay water-shed. The economic possibilities of most of this lignite were investigated and reported upon for the Bureau of Mines in 1904, by J. M. Bell.[10] New and rather extravagant reports, however, were circulated during the winter of 1909-1910 to the effect that real "coal" had been discovered in the vicinity of the Grand Trunk Pacific railway on the Mattagami river. Several square miles of claims were staked out and recorded. The investigation of these reports was one of the primary objects of this expedition. A very brief examination served to convince the writer that the deposit had few economic possibilities. A short interim report to that effect was sent to Mr. Gibson, the Deputy Minister of Mines, and no further staking of coal took place during the summer of 1910.

Lignite or brown coal may be described as a fuel about half way in the state of carbonization between peat on the one hand and bituminous coal on the other. The term is a loose one, and includes materials of wide divergence in chemical composi-

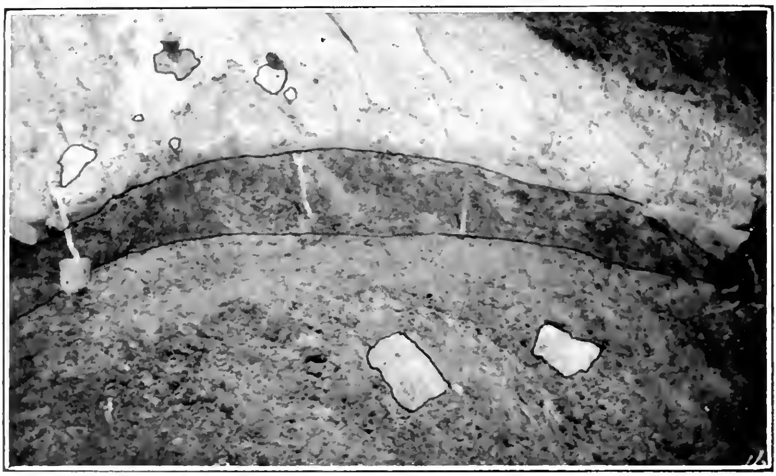


Fig. 24.—Lignite fold cut off by glaciation.

tion, in texture, and even in mode of occurrence. The "braun kohl" of Saxony is so soft that it is dug from the field with spades, and piled in great stacks to dry, when it forms a valuable fuel. On the other hand, the lignites of the Western States and those of Western Canada are black, comparatively highly carbonized, firm, even with conchoidal fracture, and require to be broken with a pick. The lignites of the Moose region are, considering their recent age, in a remarkably advanced state of carbonization. (See the analyses given below.) Some of them compare favorably with the lignites of Souris and Lethbridge, others are typically brown, resembling the German variety. As already mentioned, the lignites of northern Ontario are of interglacial age, occurring in stratified beds of clays, sands, etc. These coal measures occur extensively throughout the whole Moose Basin, but they do not always carry lignite, although in general they are more or less carbonaceous.

The lignite of the Mattagami river outcrops at the east bank about one mile upstream from Big Bend, or about eighty miles down stream from the railway. The location is shown on the map accompanying this report. The outcrop cannot be seen except in the lowest water. It then shows in two narrow seams dipping into the east bank at an angle of about 50°,and striking W. 30° S. The upper seam is six

[10]Economic Resources of Moose River Basin, Bur. Min., Vol. XIII. (1904).

Fig. 25.—Tree trunks and limbs buried in lignite.

Fig. 26.—Iron ore exposure, Mattagami river.

feet thick at the thickest place; lying below this are four feet of clay quite dark and lignitic in places, followed by one foot of lignite, below which is a fat, lead-blue clay, which was bored into for sixteen feet without showing further lignite.

The method of examination was by boring, carried on by means of an-inch-and-a-half auger, welded into gas-pipes, which we carried in five-foot lengths. These could be screwed together, giving a total length of twenty-two feet. By drawing the core every three to five inches, the exact nature of all material passed through could be readily determined (Fig. 23). One pit, five feet square, was also dug for ten feet to show the nature of the deposits, and subsequent borings were readily compared with the layers of material passed through in the digging.

These lignites do not occur in beds associated with consolidated rocks, but in beds both overlaid, and underlaid by clay and sand of inter-glacial age. That this is the occurrence is clearly shown by beds of boulder clay, carrying striated pebbles, which underlie and others which overlie the lignite series, while the lignite series itself is made up of beds of clay of a deep lead-blue color, also bands of grayish white sand, beds of lignitic clay, and lignite itself. All this series is absolutely free from boulders or other glacial material.

Fig. 27. Limonite showing botryoidal form.

The lignite is in beds of quite irregular thickness; in places these are warped, shoved, ploughed, and crushed out of shape. The folds are often cut off by glaciation (see Fig. 21), at other times the beds are cut out entirely by glacial erosion. These same characteristics are mentioned by Mr. Bell in his report on the lignites of other parts of this area.[11] In the glacial drift immediately overlying, or to the south of the best exposures of lignite near the Big Bend on the Mattagami river, are found rounded, scoured boulders of lignite, like other boulders in the drift (see Fig. 18), clearly showing that the later advance of the ice scoured off portions of this inter-glacial lignite series.

Most of the lignite is laminated, showing stems, twigs, leaves and reed-like characters, but buried in this looser material are many sections of the limbs and trunks of trees (see Fig. 25). By digging up some of the lignite a few of the larger of these trees were secured, the largest one measuring seventeen inches in diameter. This would represent a rather substantial tree before compression. Scattered abundantly through the loose lignite are fragments of perfect charcoal, which have

[11]Bur. Min., Vol. XIII. (1904), p. 161.

been preserved as fragments of charred wood, as if a fire, probably started by lightning, had passed over this portion of the area, leaving pieces of charred wood which are now scattered through the lignite at this point. Many of these pieces have all the appearance of charred cedar, with its typical silky, slivery or flaky character, with which anyone who has seen it is familiar.

Analyses of Lignite

Locality.	Fixed carbon.	Vol. combustibles	H_2O	Ash.	Remarks.
Lethbridge, Alberta	54.93	26.87	12.08	6.12	High grade, firm cannel-like.
Golden City, Colorado	45.57	37.15	13.43	3.85	Buried 50 ft. below surface.
Moose River, Ontario	44.03	41.39	11.74	2.84	Collected by Dr. Robert Bell.
Souris River, Manitoba	40.72	38.58	16.92	3.78	Firm, conchoidal fracture, buried 100 ft.
Big Bend, Mattagami River	40.31	39.21	11.45	9.00	Woody lignite, light yellow ash.
Big Bend, Mattagami River	40.53	46.41	11.22	1.84	Frag. of tree, jet like, conchoidal fracture.
Blacksmith Rapid, Abitibi River	36.58	39.66	16.16	7.28	Mossy lignite.
Big Bend, Mattagami River	26.25	40.13	12.27	21.05	Mossy, loose, reedy ; reddish ash.

Fig. 28 Iron ore deposit, Mattagami river.

From the analyses above it is surprising to note how well carbonized is this lignite, considering its recent age, but it is evident that the interglacial period itself in which this lignite was formed was of long duration. Not only was there deposited a considerable thickness of stratified clays and sand, but there was sufficient time for a great peaty or swampy growth, as well as for trees of large size to mature, be buried and thoroughly carbonized before the next glaciation, for the fragments of lignite found in the drift, as mentioned above, are evidence that the lignite had formed before the later glaciation, and that its carbonization was then quite complete.

From the amount of carbonization that the lignite in general has undergone, as shown by the analyses, it can be seen that this lignite is of rather low grade, but is sufficiently carbonized to produce a good fuel if briquetted. The difficulty with these lignites of northern Ontario is their irregular thickness, and lack of continuity. They are of wide distribution, but in scattered patches, and of variable thicknesses. Moreover, they are buried beneath loose accumulations of sand, clay and drift, which probably could not be economically removed, or supported by timbering or otherwise, as the roof would not be solid rock but loose material, and, therefore, neither self-sustaining nor capable of being held in place by pillars of coal, or by timbering within a reasonable cost. This lignite has a decided tendency to slake or disintegrate upon exposure to the air. Even the solid, jet-like fragments of trees very soon crumble to small pieces,

so that even were the deposits thicker and more easily mined, the lignite would require briquetting before it would be of much importance commercially. Beyond local use, confined to the outcrops from which a few tons might be economically mined, it does not seem that the lignite of the Moose Basin has an economic value.

Iron

The iron ores on the Mattagami river were discovered by Dr. Robert Bell and described by him[12] as follows:

> This locality is remarkable for the occurrence of a large deposit of iron ore. Its position is on the northwest side of the river, at the foot of the rapids. It runs along the foot of the cliff for a distance of upwards of three hundred yards, almost continuously, with an exposed breadth of twenty to twenty-five yards. The highest points rise about fifteen feet above the level of the river. The surface is mottled, reddish-yellow and brown, and has a rough spongy or "lumpy" appearance, like that of a great mass of bog-ore. At the surface and sometimes to a depth of several inches it is a compact brown hematite, occasionally in botryoidal crusts, with radiating columnar structure; but deeper down it is a dark-grey compact, very finely crystalline spathic ore, apparently of a pure quality. The brown hematite evidently results from the conversion of the carbonate.

The deposit was also examined and reported on in more detail by J. M. Bell.[13] Both these geologists appear to have seen only the deposits at the foot of the rapids, whereas deposits of equal size and possibly of equal richness occur at the head of the rapids, one mile and a half farther up stream. These deposits occur on both banks of the river. They extend across the bed of the river at both places, and they stretch along the shore for about eleven hundred feet in each case. They reach in places fifteen to eighteen feet above the level of the river, but their full thickness cannot be estimated, as they extend below water level in almost every case (Fig. 26). Nor could it be ascertained how far they extend inland from the banks of the river, but from the fact that the ore-belt is eleven hundred feet wide, and extends across the full width of the river, a distance of a quarter of a mile, the conclusion was reached that it will extend inland for a similar distance at least. This opinion can only be verified by boring or mining, and as many claims are staked back from the river information from drill-holes, etc., should soon be forthcoming as to the continuance of the ore inland.

In some places the ore is a soft, often botryoidal, vuggy limonite, in radiating, lumpy masses (Fig. 27). At other places it is a dense, hard hematite, or a compact limonite. Again it passes into coarse breccia, composed of fluted, water-worn fragments of the Corniferous limestone, and rounded boulders of siderite, the whole cemented by limonite; or at other places it is a quartz conglomerate, composed of small water-worn pebbles of quartz in a matrix of clay and limonite. Other phases show the ore as clay, impregnated by limonite, all stages of impregnation being found as shown by the following analyses:

	Iron, per cent.
1. Clay of the country in general	2.46
2. Clay visibly reddened by the presence of iron oxide	6.30
3. Clay of ochreous color	11.38
4. Clay decidely limonitic	28.25
5. Clay in appearance, but a low-grade limonite ore	33.19
6. Clay in appearance, but a good limonite ore	48.45

In the case of these clay-iron ores, the passage from one to another type is so gradual, and the clay characters are so well preserved, that there is no possible doubt of their forming one series. The deposits are of a mixed character, in some places the material being high enough in iron to constitute a good ore, but in other places the

[12] Geo. Sur. Can., 1875-6, p. 321.
[13] Bur. Min., Vol. XIII. (1904), p. 152.

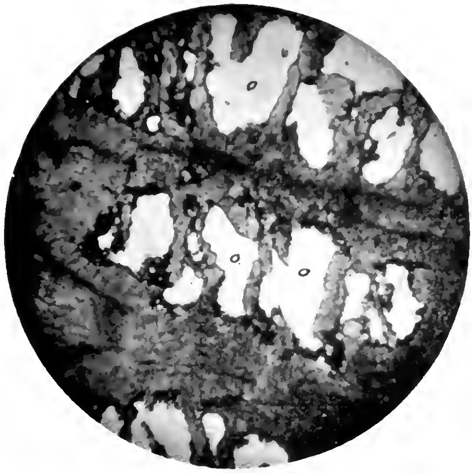


Fig. 29.—Ferruginous limestone with fossils unaltered.

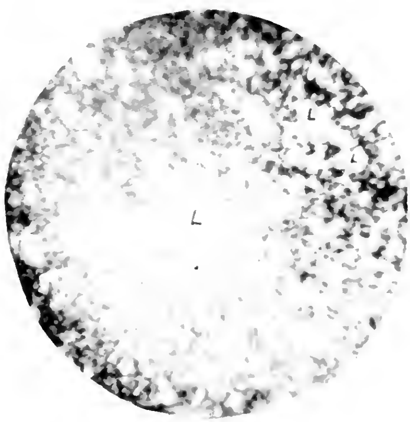


Fig. 30.—Ferruginous limestone, non-fossiliferous.

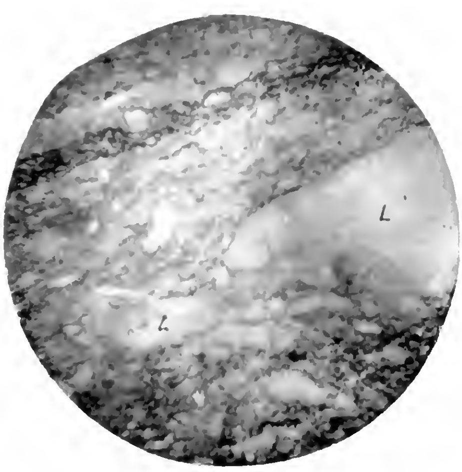


Fig. 31.—Limestone with limonite in lines of weakness.

percentage of iron in the alluvial accumulations is quite low. This fact is well demonstrated by the following analyses of selected samples from the ore-bodies.

No.	Iron.	S.	P.	Moisture.	——
1	52.45	0.14	0.08	1.16	Average of the best ore at the foot of the rapids on the north side.
2	52.10	0.11	0.14	0.94	Best ore below high water mark foot of the rapids on the north side.
3	41.68	0.15	0.12	1.7	Average ore from the foot of the rapids, south side.
4	37.35	0.16	0.13	1.56	Average of the best ore at the head of the rapids, south side.
5	36.68	0.60	0.09	1.42	Average of 850 ft. of exposure at the head of the rapids, south side.

None of these would be a Bessemer ore, but some are well suited for open hearth treatment.

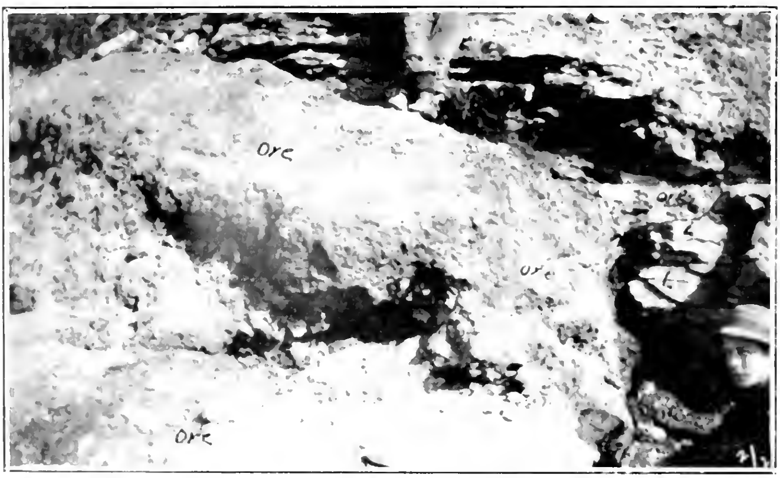


Fig. 32. Ore in contact with limestone wall.

Origin of the Ore

Speaking of the Mattagami river deposit, J. M. Bell says:[14]

The limonite occurs at the base of cliffs of limestone, lying almost horizontally thirty to forty feet high, overlain by fine-grained boulder clays and silt. Its continuation toward the interior is hidden by these overlying rocks, and its appearance at the foot of the cliffs often obscured by the talus resulting therefrom. All the limestone overlying the ore contains iron carbonate, the lower part or that in close proximity to the ore being often decidedly ferruginous. The mass of the ore has resulted in part from the direct oxidation of the siderite in this iron-bearing limestone, and in part by the replacement of calcareous and other impurities contained within the iron carbonate of the limestone, by hydrous iron oxide, deposited either as siderite and subsequently oxidized, or directly as hydrous iron oxide in cavities. This ferruginous material is brought in solution as carbonate by waters containing carbon dioxide, and is doubtless leached from the wide area of siderite-bearing limestone above the ore stratum.

From the foregoing it is clear that Mr. Bell believed that the ore was due to the leaching of the Devonian limestone. Dr. Robert Bell, however, in his report of 1875, says:

The geological relations of this singular deposit are puzzling. It may be of newer date than the limestone gorge in which it occurs. The adjacent overlooking wall of soft earthy limestone is worn into vertical caverns, with fluted and rounded walls, like

[14]Bur. Min., Vol. XIII. (1904), p. 152

the sides of great pot-holes (Fig. 28). They are sometimes partially lined with a thin coating of a highly ferruginous carbonate. The iron ore was nowhere seen in contact with the rock.

Regarding the origin of the ore, the writer is of opinion that it was not derived from the Devonion limestone, but rather that the limonite and hematite are due to the oxidation of the Animikie siderite, found in place at the head of the rapids and already referred to. This Animikie siderite is believed to exist at many places about the edge of the Paleozoic coastal plain. In reading the reports on the various rivers of this area one is impressed with the regularity with which iron-holding deposits occur about the edge of the basin, and it would appear that about the margin of the Paleozoic area, where the sediments are naturally thinnest, they are eroded in many places so as to actually expose the underlying siderite. The weathering of the siderite produced residual limonite and hematite, or supplied springs or other waters with a load of iron carbonate, to be carried to new resting-places, there to be oxidized and deposited as limonite, hematite or magnetite, the last of which was found in a few cases. Professor Van Hise, in his treatise on "Metamorphism,"[15] accounts for such deposits as follows:—

$4\ FeCO_3 + 2O + 3H_2O = 2\ Fe_2O_3 3H_2O$ (limonite) $+ 4CO_2$.
or $2\ FeCO_3 + O = Fe_2O_3$ (hematite) $+ 2CO_2$.
or $3\ FeCO_3 + O = Fe_3O_4$ (magnetite) $+ 3CO_2$.

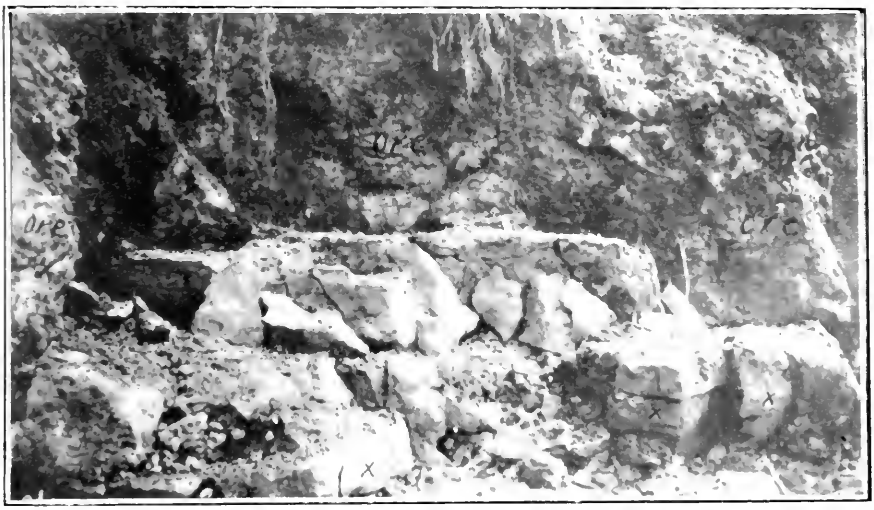


Fig. 33. Ore body resting on limestone.

The natural exposures at no place showed ore in actual contact with the limestone, so that its relationship to the wall-rocks could not be seen. Several of these deposits were therefore stripped to show the contacts, and a party of men doing assessment work for Mr. Foster Shields also uncovered contacts, so that the fluted water-worn cavities could be easily seen and were very characteristic. In these cavities in the Corniferous limestone the iron-bearing waters have deposited their loads chiefly in the form of limonite, which in some cases has been altered to hematite.

It is evident that the cavities were made before the ore was deposited, and not by replacement or any such process, for there is only the slightest amount of replacement to be seen, even in the most suitable places. Fossiliferous portions of the limestone

[15]Monograph XLVII., p. 233.

show the ore filling the pores of the fossil, while the calcareous frame-work is entirely unattacked (see Fig. 29). At other places where the limestone is not fossiliferous, the grains of the calcite can be clearly seen to be intact, while the limonite is present as interstitial filling (see Fig. 30), or as streaks along the lines of weakness in the limestone (see Fig. 31). Moreover, the ore is in sharp contact with the fluted pot-hole-like walls of the limestone (see fig. 32), showing clearly that the ore-bearing waters found the cavities waiting for them.

Limestone not Source of Iron

In accounting for the supply of iron to form such deposits it would not appear that the Devonian limestone is sufficiently rich in iron to have supplied the requisite

Fig 34.—Ore showing inclusion of limestone blocks.

amount. In support of this conclusion may be instanced a deposit of good ore resting upon a limestone floor, shown in Fig. 33. There is a distinct knob of limestone sticking up within the ore-body, as shown in the photograph. From one of the layers of limestone, which by its thickness and other characters could be followed from side to side, samples were taken from each contact, at equal distances in from the contact towards the middle of the body, and at the middle. The analyses of these are quite instructive, for they show that proceeding from the ore into the limestone there is less and less iron, and a perfect correspondence in the decrease as well.

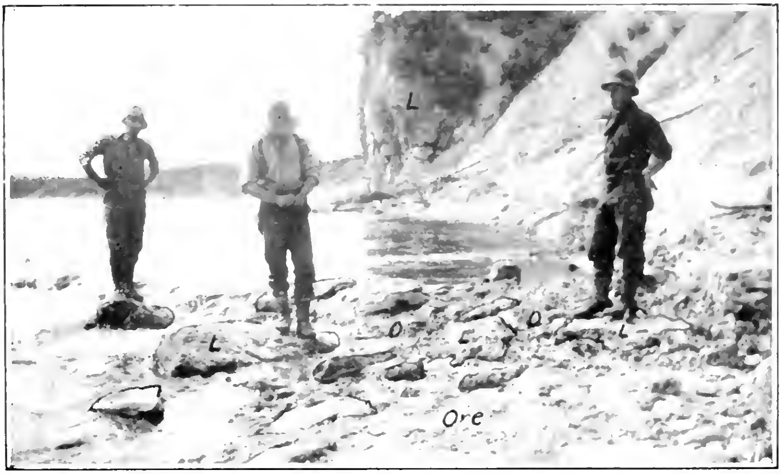


Fig. 35.—Ore showing inclusion of limestone blocks.

Fig. 36.—Ore showing glacial striations.

	Iron per cent.
Sample No. 1—At the actual contact, left side of exposure	6.50
Sample No. 2—2 inches in from the contact, left side exposure	3.22
Sample No. 3—1½ feet from the contact, left side exposure	1.80
Sample No. 4—Centre of body	0.65
Sample No. 5—1½ feet from contact, right side	1.28
Sample No. 6—2 inches from the contact, right side	3.58
Sample No. 7—Actual contact, right side	9.90

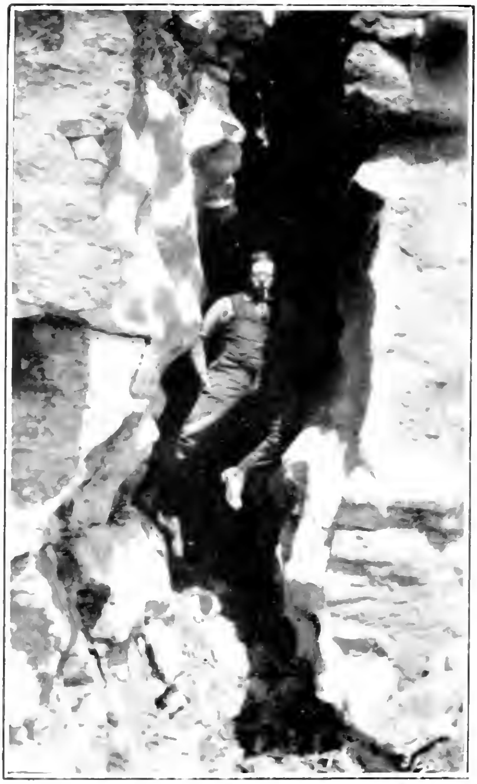


Fig. 37.—Enlarged joint-plane in limestone cliff.

The various evidences cited above show clearly that the iron in the Devonian limestones found its way into them from cavities rather than in the reverse direction. Attention is also called to the large blocks of fresh limestone sometimes found included in the ore (see Figs. 32, 34, 35), and to the sharp, clean contacts between them and the ore, showing absolutely no signs of replacement or decomposition. They are simply pieces of the wall-rock that have been water-worn, and later buried by the ore deposition. Moreover, with all the stripping and uncovering of ore that was done during the summer by Mr. Shields' men and those of my own party, not a single instance was observed in which the limestone overlaid the ore. In every case the ore occupied an open pocket or basin, with nothing but loose glacial or other drift above it. The various photographs taken of these contacts supply indubitable testimony that the cavities were made before the ore was deposited.

The exposed ore is therefore post-Devonian in age, and most of it is pre-Glacial, for rounded boulders of it are found in the glacial drift as far south as the Long Portage, a distance of twenty-five miles. Moreover, the ore itself is distinctly glaciated

in places (Fig. 36), one piece brought home showing distinct glacial striæ. A small portion of the ore is a cemented glacial drift, and some of it is certainly modern, for it can be seen forming in many local hollows, and along the banks of the river in many places, where chalybeate springs issue. This seepage from the banks is so laden with iron oxide that several prospectors reported the country to be rich in petroleum, mistaking the scum of iron oxide for oil stains. These latter occurrences, however, are of insignificant extent, and so poor in iron content as not to be regarded as ore. Practically all the real ore is pre-Glacial in age.

Origin of the Cavities

The origin of the cavities or pockets that now hold the ore can only be surmised. One thing is evident, however, that they are water-worn, erosion channels, and to some degree solution spaces, in the limestone. The general character of them is well seen in Fig. 37, which shows them to be original joint cracks of the limestone, widened by solution and erosion to very large cavernous passages. These particular cracks extend not only down the full height of the cliff to the water, but can be seen from the top of the cliff to preserve the same course out into the rapids as far as they can be followed.

It is very doubtful if this coastal plain was under water again after the Devonian limestone was laid down until Pleistocene times, for no higher sedimentary horizons have been discovered in this area, and it is not conceivable that glaciation would have removed every vestige of them had they been present. If, therefore, this plain was a land surface from the close of the Devonian till the Pleistocene, with its drainage by lakes and rivers as now, it can be easily imagined that the thinner places, for example the edges, should be eroded through in many places to the underlying pre-Cambrian, and many of its main fractures, or joint planes, enlarged to irregular cavities by drainage waters.

It has already been pointed out that what was believed to be Animikie siderite was found *in situ* (see Fig. 16), in the immediate vicinity of these deposits. From this and similar occurrences of siderite seen by others in this basin, there can be no doubt that many outcrops are covered only by glacial drift, as these would also be were they not exposed by the present rivers having cut through the drift to the bed rock. With these basins, pockets, and drainage channels in the limestone, and the rich deposits of siderite in the immediate vicinity, it is an easy matter for the iron carbonate to be dissolved, carried with the drainage waters, oxidized, and deposited in the various forms in which it is now found.

Where the limestone has been eroded or dissolved through to the underlying siderite, deposits of weathered limonite on top might be expected, which would change with depth to siderite, thus accounting for occurrences such as Dr. Robert Bell reports:[16] It will be noticed that the only places where iron ores are reported about this basin are where the present rivers have cut through the drift to bed rock, and as already mentioned, it is only here that the rocks outcrop. In all other localities from twenty to seventy feet or more of glacial drift, overlaid by the later shell-bearing sand series already described, cover the deposits. There is therefore good ground for the belief that were it not for the drift much more iron would be exposed than can now be seen.

It is possible that this Animikie siderite itself could easily become an ore. It is exceptionally high grade, as shown by the following complete analysis:

SiO_2	Al_2O_3	FeO	Fe_2O_3	MnO	CaO	MgO	CO_2	Carbon	S	H_2O	Sp.G.
1.40	2.31	54.31	1.67	1.74	1.47	Trace.	34.94	1.27	0.0	0.50	3.63

[16] Geo. Sur. Can., 1875, p. 321.

This analysis gives 43.27 per cent. iron, and by simply calcining the siderite over a Bunsen burner the carbon-dioxide was driven off, giving a product which analysed 63.74 per cent. iron. in many parts of Europe spathic iron ores, of much lower grade than this, are calcined; in some cases in open heaps, sometimes in continuous kilns, and sometimes in roasting furnaces, using gaseous fuels. It is possible, therefore, that with a high grade siderite, plenty of local fuel, for example lignite, or peat, or charcoal made from the birch forests of the north country, this siderite could be easily converted into a high grade ore, thereby reducing the freight rates to such a degree as would allow of the long haul necessary to bring them to the smelters. Without wishing to be too optimistic, it would appear to the writer that this is a phase of the question worthy of some consideration.

NOTES ON THE SALT INDUSTRY OF ONTARIO

BY N. L. BOWEN

Introduction

Salt was first discovered in Ontario near Goderich in 1865 while drilling was being carried on for oil. Other wells were put down with salt as their object, and a stable industry was established which has continued till the present time.

Distribution and Occurrence of Salt

The area in Ontario in which salt is now known to occur, lies entirely in the southwestern peninsula bordering lake Huron, the St. Clair river, lake St. Clair and the Detroit river. It exists as beds in the Salina formation of the Silurian system, which formation in the productive area is covered by upwards of 1,000 feet of other strata, chiefly Devonian.

Origin and Nature of Beds

Salt is the mineral halite, chloride of sodium, and is the chief dissolved constituent of sea-water. Beds of the mineral are believed to have been formd by partial evaporation of a cut-off arm of the sea or of a salt lake. In Salina time, conditions favoring this prevailed over much of southwestern Ontario, and the states of Ohio and New York. Such exploratory boring as has been done indicates that a number of separate, relatively small, basins were formed rather than a single large one. The beds range from mere seams to those two hundred feet and more thick.

Other salts of sea water separate in greater or less amount during the process of evaporation. Thus gypsum, hydrated sulphate of calcium, commonly accompanies salt, but is usually in distinct beds owing to the very different solubility. The salt itself always contains some chloride and sulphate of calcium or magnesium or both.

Analysis of Rock Salt

Being diamond drill core from Attrill's well, Goderich.

	Per cent.
Salt, NaCl	99.687
Chloride of calcium, $CaCl_2$	0.032
Chloride of Magnesium, $MgCl_2$	0.095
Sulphate of calcium, $CaSo_4$ (with water-gypsum)	0.090
Insoluble water	0.017
Moisture	0.079
Total	100.000

Extraction

All salt is procured in Ontario by allowing water to penetrate to the beds, a brine being thus formed. This is pumped to the surface, where by various processes of evaporation the salt is recovered.

Drilling Wells

The drilling of wells is accomplished by churn drills; a heavy bit on the end of a cable is lifted a few feet and allowed to fall about once a second and by its impact cuts its way into the strata. The drill is taken out every hour and the cuttings and sludge removed from the hole by means of a cylinder with valve bottom. The diameter of the hole is about 8 inches.

Piping

Piping through which the brine may be pumped to the surface, is then put in. The system of piping varies at different plants. If the water used to form the brine is simply ground water (that is, water which circulates in porous strata and runs into the well of its own accord) a single pipe, extending to the salt, with the plunger of the pump put down to the depth necessary to raise the brine, is all that is required. An objection sometimes raised is that ground water often carries much gypsum in solution, and in this way an undesirable substance is introduced into the brine and thence to the salt.

At some plants where a supply of lake or river water is available advantage is taken of this purer water. In this case, it is necessary to have double piping. Between the outer and inner, fresh water is forced down and in the inner brine rises to the surface. The case pipe, as in general use, has an internal diameter of 6¼ inches, and the brine pipe 3½ inches. This system has the further advantage that the head of water is sufficient of itself to raise the brine to within a short distance of the surface, not however the whole distance since the brine is denser than the fresh water. It is of advantage that the brine pipe should reach to the bottom of the solution cavity formed in the salt bed for here the heavier and more saturated brine occurs. The case pipe, on the other hand, is not extended to the bottom, but is caused to rest on a firm rock ledge above the salt stratum, the joint being made 'tight' by a heavy rubber collar on the end of the pipe. The system must have no leaks for in such case the "head" is lost.

When a large quantity of salt has been dissolved out, overlying strata, if of a weak character, often cave in and break the pipes and many annoying delays are thus occasioned. In such cases it is necessary to drill through the broken debris and extend the pipe to the bottom.

The contract price for drilling is at present $1.65 per foot, the average cost of a well complete and ready for pumping being about $5,000.

The Brine

The brine as it comes to the surface is, when the system is working properly, a completely saturated solution of salt. A simple density test with a salometer suffices to ascertain the saturation. The salometer is a hollow tube weighted in one end. It floats in an upright position in the brine, and at different levels, according to the density of the brine. The tube is calibrated to read 100 when saturation is complete—that is, when the water has dissolved all the salt it will dissolve. The proportion is roughly 75 parts by weight of water to 25 of salt.

Treatment of Brine

The brine is first pumped to the settling tanks, where any sediment is allowed to settle and where at some plants it is treated with lime, which causes the precipitation and removal of iron and any bicarbonates. In most cases such treatment is quite unnecessary.

Analysis of an Ontario Brine

	Per cent.
Sulphate of calcium	0.4406
Chloride of calcium	0.062
Chloride of magnesium	0.027
Salt	25.68
Water	73.78

Evaporation

The brine now runs to the evaporating pans, which may be one of several types, but which separate themselves into two classes.

1. Open pans.
2. Vacuum pans.

In open pans the brine is heated in contact with the atmosphere, and as the water evaporates salt is deposited and raked out.

Open pans proper, as referred to in the trade, are large flat pans, commonly 100 x 40 feet, with a depth of 2 feet. Beneath one end is a fireplace and the direct heat plays on the pan. Evaporation at the fire end is brisk, the brine boiling vigorously, and the salt separates in fine crystals. Farther from the fire evaporation is more retarded and coarser and coarser crystals separate with increasing distance. In this way the product is graded.

Salt crystals form at the surface, since it is there the water vapor is lost to the atmosphere. They sink to the bottom because heavier than brine, and from there are raked out. Raking is accomplished by hand or by different mechanical devices, such as an endless belt with rakes, or an oscillating beam with rakes so spaced that the load brought forward and dropped by one is picked up by its neighbor and thus moved on another step.

Sometimes, instead of direct fire, steam heat is used. In this case steam pipes are hung within the pan, or a steam chamber is constructed beneath the pan, and when steam is let in uniform evaporation of the brine ensues. Such pans are called "grainers." The rapidity of evaporation and therefore the coarseness of the salt can be easily regulated. This method is often used where a supply of exhaust steam is available, and in such case affords a very economical means of evaporating. Raking may be mechanical, or by hand, as in the "open pan" method.

Behaviour of Foreign Constituents

The level of the brine in pans of all types is kept approximately constant by a continuous flow of new brine, which takes the place of evaporated water. The chlorides of calcium and magnesium do not separate with the salt, and there is, therefore, an increasing concentration of these salts in the pans. The brine is said to become "sour." If allowed to continue, the brine will become saturated with these chlorides and they will be deposited in considerable amcunt. They have such a strong attraction for water that if contained in salt, except in the minutest quantity, they render it continually damp, thus causing it to cake. The process must, therefore, be interrupted every two or three weeks to run off "souring" brine.

Most of the gypsum which separates tends to form a coating which adheres firmly to the pans and is removed at intervals by scraping. This action of gypsum is due to the fact that a great deal of it separates not on account of evaporation, but simply on account of the raising of the temperature of the brine, calcium sulphate, unlike salt, being decidedly less soluble in water at the boiling temperature than in cold water. Since it is at its contact with the pan that the solution first feels the temperature effect, it is here that the gypsum separates. So also the steam pipes of grainers become coated.

At some of the plants one end of the open pan is reserved for simply warming the brine before it passes to the evaporators. Although this is done merely to keep the evaporators from getting "off the boil," it has the additional advantage of taking out much gypsum. Gypsum is not an especially objectionable impurity in salt, but is of course undesirable.

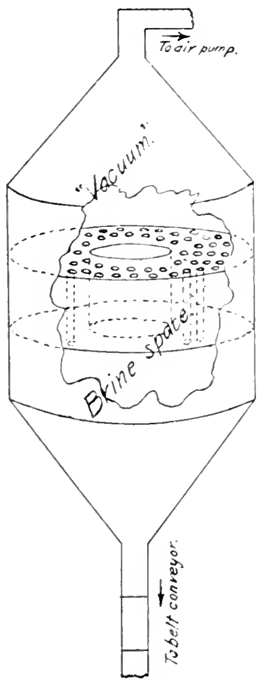
Vacuum Pans

In vacuum pans the brine is caused to boil under reduced pressure, the boiling point being lower as the pressure is lower. Vacuum pans are therefore closed pans, or really tanks, in which the brine rises to a certain level, and above this a reduced pressure is maintained by means of an air pump. Heat is supplied by steam. The brine circulates in the tubes of a drum about centrally placed in the tank and steam is contained in the space between the tubes. Fine-grained salt forms rapidly and settles through the boiling brine down a pipe, where by a double valve arrangement it passes out and is picked up in the scoops of a belt conveyor. A rough idea of the construction is to be obtained from the following sketch.

This is, on account of the low boiling point of the brine, an especially effective method of using exhaust steam.

The plant is sometimes arranged in "double effect," that is, the steam from the brine in the "first effect pan" passes over into the steam drum of a "second effect pan," where a greater vacuum is maintained. The temperature of the steam is sufficient to cause the brine to boil under its further reduced pressure. In this manner greater efficiency is obtained from a given amount of steam.

In the first effect pan a vacuum of about 24 inches is commonly maintained, that is, the pressure is equal to 6 inches of mercury, or is one-fifth of the atmospheric pressure of 30 inches. At this pressure the brine boils at about 155° F. In the second effect pan a vacuum of about 27 inches is maintained, the pressure then being about one-tenth the atmospheric pressure. The brine boils at about 105° F. The single effect



Vacuum Pan.

process must be interrupted about every 12 hours in order to clean the tubes of gypsum coating, to accomplish which it is necessary to resort to drilling. So also in the double effect process, the first effect pan must be cleaned every 12 hours, but the second effect pan needs to be cleaned of gypsum only every year. This affords a striking example of the effect of temperature in precipitating gypsum, that in the first effect pan being so decidedly higher than that in the second effect.

In vacuum pans the finest grades of table and dairy salt are made.

Drying

By whatever method made, the salt must first be dried. This is accomplished at some plants simply by allowing it to drain thoroughly. At the larger plants it receives a further drying in the drying drum. This is a revolving cylinder, 20 to 30 feet long and 6 to 8 feet in diameter, placed with its axis at a small angle from the horizontal. The salt enters at the higher end and passes slowly to the lower, always forming a thin layer on the inside of the cylinder and being exposed to a moderately high temperature.

Sizing and Packing

The salt is then sized by bolting. The product of all grades is thus made up of individual crystals, this being much preferred in the trade to ground salt.

The different grades pass to the packing rooms, where they are put into barrels, bags, or packages, according to the use for which they are designed. Most of the works have their own cooper shops.

Price of Salt

The price of the product varies greatly for the different grades, the average being about 90 cents per barrel of 280 lbs.

Market

The bulk of the salt manufactured is used in Ontario; a considerable proportion goes to the Western provinces, and a smaller quantity as far east as the Maritime provinces. The chief competitors in the market are English and American salt. A reference to the table of imports of salt and production of the same given later shows that the amount imported into Canada in one year is nearly twice the domestic production, although the total value of imports is somewhat less. This is due to the fact that it is largely the cheaper grades of salt which are imported.

When coming from the United Kingdom, salt enters Canada duty free. If for use in sea or gulf fisheries, it enters free from any source. On salt designed for other uses and coming from countries other than the United Kingdom, duties are imposed as follows:

Salt packages from United States........................	25 per cent. ad valorem.
Salt in bulk from United States.........................	5 cents per 100 lbs.
Salt in bags, barrels, etc., from United States...........	7½ cents per 100 lbs.

Some protection is thus afforded the Canadian producer, but it is claimed that even in Ontario American salt is used to some extent in butter making.

Uses of Salt

The uses of salt are well known to all. The finest grades are used for the table and dairy, coarser grades for packing meats, curing hides, feeding to cattle, and for an endless variety of purposes. Crude salt, including the scrapings of the pans and the sweepings of the floors, is often used as fertilizer under the name of "land salt." This is, of course, entirely used locally, as it will not bear transportation. It is claimed that good results are obtained.

Salt is also the raw material from which practically all soda and chlorine products are manufactured. These include the common baking soda, washing soda, caustic soda (the base of soap), muriatic acid, bleaching powder, chlorates and a number of other materials which have come to be necessaries of life.

Supply and Demand

The Ontario supply of salt is, to all intents and purposes, inexhaustible. When it is pointed out that a bed 30 feet thick, extending over an area of one acre, would contain over 80,000 tons (equal to the yearly production), and that there are several such beds, extending over many thousands of acres, one realizes how true this statement is. The production is limited only by the demand. This would be increased by greater success in competition with foreign salt, or by the establishment on the ground of chemical industries in which salt is used as a raw material.

This latter is an especially desirable departure in Ontario, as will be seen from the table of imports of soda and chlorine products into Canada, given later.

Salt Plants

Canadian Salt Company, Windsor

The plant of the Canadian Salt Company at Windsor is the largest in the Province. Most of the salt is made in a double effect vacuum pan system. Two first effect pans are run alternately in connection with the one second effect pan. While one of the former is in use the other is being cleaned of gypsum, a process which is necessary every 12 hours. The second effect pan is cleaned every 36 hours by boiling. The first effect pans are each 12 feet in diameter and the second effect 20 feet.

Coarser salt, also, is made at this plant in two steam-heated grainers, the temperature maintained in these being about 185°. The fuel used in the boilers is natural gas.

River water is forced down to the salt beds to form the brine. Four beds of salt have been penetrated, the upper 90 feet thick, the next 30 feet, the next 35 feet, and the lowest 200 feet. There are five wells on the block, three in the top salt with a depth of about 1,200 feet, and two in the bottom salt with a depth of about 1,700 feet.

The output of the plant is about 1,200 bbl. per day, the capacity being considerably greater. Employment is given to 120 persons. Shipping facilities, both by rail and by water, are of the best.

The Canadian Salt Company has another plant at Sandwich, with an output of 400 bbl. per day, made by the grainer method. It is planned to construct at the Sandwich block a plant for the manufacture of soda and bleaching powder by an electrolytic process.

Dominion Salt Company, Sarnia

The Dominion Salt Company is the name under which the Cleveland-Sarnia Lumber Company conducts its salt business. The plant is that formerly operated by the Empire Salt Company.

There are in use two grainers and a single effect vacuum pan 10 feet in diameter. The brine is obtained from two wells, and a third was being drilled at the time of the writer's visit. River water is used. Following is a rough log of one of the wells:

1,627 feet	"rock."
35 feet	salt.
12 feet	limestone.
126 feet	salt.

Exhaust steam from the saw mills is made use of. This is not alway available, so the plant does not run to full capacity. Only when there is excessive demand for salt is coal fuel resorted to. One thousand bbl. per day could be made. The daily average of the total production for 1909 was about 410 bbl. Thirty-five persons are employed on the block. Transportation facilities are the very best.

Empire Salt Company, Sarnia

This company is not at present producing salt, but plans the erection of a 1,000 bbl. per day plant on the Indian Reserve south of Sarnia.

Western Salt Company, Mooretown

At this plant the open pan method is in use. The pan is 90 feet long and 20 feet wide, and is heated by a coal fire. The salt is raked out by hand. The brine comes from one well 1,870 feet deep. The saltbed is 100 feet thick and there is good reason to expect another at 2,200 feet

Thirteen persons were employed during 1909 and 12,674 bbl. shipped. The company plans the erection of a plant at Sombra.

Elarton Salt Company

At this plant the open pan method is in use. The pan is 60 feet long and is heated by a wood fire. The well is 1,460 feet deep and the salt is 130 feet thick with partings of shale.

Ground water leaks into the well and forms the brine.

The plant is in operation only a part of the year and supplies only local demand.

Western Canada Flour Mills Company, Goderich

This company operates a salt block in connection with the mills. Two open pans are in use and are heated by exhaust steam from the mill, which is let into the steam chamber beneath the pans, only coarse salt being made.

The brine comes from one well 1,100 feet deep, extending 16 feet into a salt bed of unknown thickness. Two pervious strata at 260 and 340 feet supply an abundance of water. An excellent log of a Goderich well is given later in the results of diamond drilling at that place.

The output is about 220 bbl. per day, all of which is shipped by rail to Ontario points. Seven men are employed.

Ontario People's Salt and Soda Company, Kincardine

At this plant there is in use a large V-shaped grainer 100 feet long and 13 feet wide, with a depth of 7 feet and a width of 18 inches at the bottom.

Tiers of steam pipes are placed in this, and into these live steam is turned. The brine is kept at a very gentle boil. Fine-grained salt settles and is taken out by an endless chain conveyor.

In a smaller and shallower pan, the steam is used a second time for slower evaporation at 150 to 160 degrees, making coarse salt.

Both pans are emptied every three weeks as the brine begins to "sour," and the process is renewed with fresh brine. Two beds of salt have been penetrated, the one 28, the other 33 feet thick. About twelve men are employed and produce 135 bbl. per day, all of which is used in Ontario. About 10 tons of coal, costing $2.75 per ton, are used in one day.

Some twenty years ago, an electrolytic soda plant was established at this works, but the process was unsuccessful, and no soda was made.

Gray, Young and Sparling Salt Company, Wingham

At the plant operated by this company, two open pans are alternately in use. The well is situated 2 miles from the works and the brine has to be pumped this distance. It is 1,185 feet deep, with 30 feet of salt.

Seven men are employed, making about 600 bbl. a week, or about 80 tons, for which about 40 tons of coal are consumed. The plant produces at this rate for only part of the year, nearly all of the production being consumed locally.

Stapleton Salt Company, Stapleton

At Stapleton, salt is made by the open pan method. Eleven men are employed and the product is, at full capacity, about 100 bbls. per day. There are three beds of salt with a total thickness of 100 feet. The plant is advantageously situated for rail shipment.

Exeter Salt Company, Exeter

At Exeter, the open pan method is used. The brine comes from one well in which it is 1,014 feet to salt with a thickness of 125 feet, including shaly partings. Six men are employed, and about 800 tons made in the year, all of which is used locally.

Parkhill Salt Company, Parkhill

At Parkhill salt is made by the open pan method. Five men are employed, working only six weeks in the year. All the salt is used in the neighborhood. The brine comes from one well 1,285 feet deep with four beds of salt, each 15 feet thick.

Logs of Wells

In describing the individual plants, the thickness of salt beds penetrated has been given, but no complete logs. Following is a list of logs which give a clue to the underground geology of the different parts of the salt area. Many more could be given, but the number has not been needlessly multiplied.

Windsor Well.			A Courtright Well.		
	Ft.	Total Ft.		Ft.	Total Ft.
Drift	....	....	Drift	160	160
Limestone	570	570	Shale (black)	32	192
Sandstone	130	700	Limestone	40	232
Limestone	356	1,056	Shale and limestone	310	542
Salt	90	1,146	Limestone	520	1,062
Limestone	30	1,176	Sandstone	32	1,094
Salt	30	1,206	Limestone	536	1,630
Limestone	100	1,306	Salt	22	1,652
Salt	35	1,341	Gypsum	13	1,665
Shale	100	1,441			
Salt	200	1,641			
Limestone	....	....			

Dictated by the driller from memory.

A Sarnia Well

	Ft.	Total Ft.
Drift	122	....
Black shale	40	....
Limestone	80	....
Shales	185	....
Limestone	30	....
Shales	46	....
Limestone	987	....
Gypsum	5	....
Shales and Salt	15	1,510
Salt	56	....
Shales	18	....
Salt	30	1,614

A Petrolia Well

—	Ft.	Total ft.	—
Drift	90	90	
Shale	240	330	Hamilton.
Cherty limestone	190	520	Corniferous.
Dolomite	690	1,210	
Salt	65	1,275	
Dolomite	20	1,295	
Salt with dolomite	140	1,435	
Dolomite	30	1,465	
Salt	90	1,555	
Salt with dolomite	50	1,605	Salina.
Salt	25	1,630	
Dolomite	10	1,640	
Salt	138	1,885	
Dolomite and shale	130	2,015	
Salt	90	2,105	
Dolomitic lime	275	2,380	Niagara.
Shale	150	2,530	Clinton.
Red shale	275	2,805	Medina.
Light shales	205	3,010	Hudson River.
Dark shales	165	3,175	Utica.
Limestone	772	3,947	Trenton.

A London Well

—	Ft.	Total ft.	—
Drift	130	130	
Limestone	1,170	1,300	Corniferous.
Salt and shale	100	1,400	Salina.
Black shale	200	1,600	Clinton and Niagara.
Red shale	500	2,100	Medina.
Limestone and shale	150	2,250	Hudson River.

A Goderich Well (Diamond Drill)

Dolomite with limestone layers	278 ft. 3 in.
Limestone with corals, chert and beds of dolomite	276 " 0 "
Dolomite with seams of gypsum	243 " 0 "
Variegated marls with beds of dolomite	121 " 0 "
Rock salt (1st)	30 " 11 "
Dolomite with marls	32 " 1 "
Rock salt (2d)	25 " 4 "
Dolomite	6 " 10 "
Rock salt (3d)	34 " 10 "
Marls with dolomite and anhydrite	80 " 7 "
Rock salt (4th)	15 " 5 "
Dolomite and anhydrite	7 " 0 "
Rock salt (5th)	13 " 6 "
Marls, soft, with anhydrite	135 " 6 "
Rock salt (6th)	6 " 0 "
Marls, soft, with dolomite and anhydrite	132 " 0 "
	1,517 ft.

Stapleton Well (near Clinton)

Drift	67 ft.
Limestone	413 "
Limestone, cherty and dolomitic	204 "
Limestone	176 "
Limestone, cherty	36 "
Shale, limestone, gypsum and marls	255 "
Rock salt (1st)	15 "
Shale, gypsum and salt	48 "
Rock salt (2nd)	25 "
	1,239 ft.

A Kincardine Well

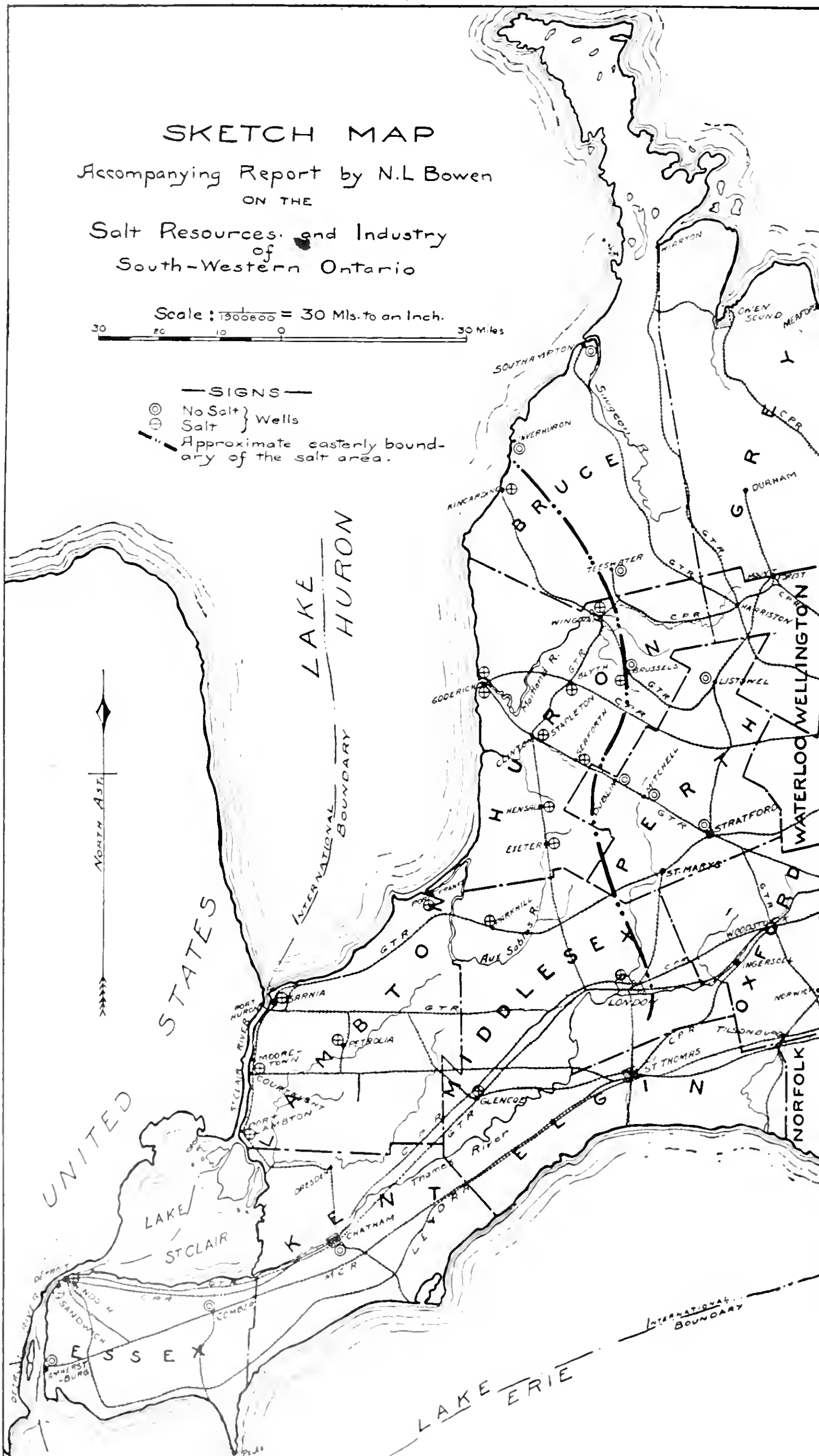
Drift	91 ft.
Limestone	509 "
Shale, red and blue	140 "
Limestone	30 "
Shale, blue and red	125 "
Rock salt	14 "
	909 ft.

Extent of Salt Area

But little exploration for salt has been carried on, largely because the production of a very few wells is sufficient to supply the demand. It might, however, be advantageous to know as far as possible the area which is probably underlain by salt beds, especially since opportunities may present themselves for the establishment of a salt industry or a chemical industry in a neighborhood where cheap fuel, cheap electrical power or some other industrial condition, would make such a course desirable.

A great deal of exploration for oil has, however, been carried on, and where the borings have extended below the salt horizon they, of course, give information as to the presence or absence of salt.

In the following, only borings which have certainly, or in all probability, extended below the salt horizon are given, and where no salt is reported the meaning is that there are no beds of rock salt. Significant localities are, beginning at the north:


SKETCH MAP
Accompanying Report by N.L Bowen
ON THE
Salt Resources and Industry
of
South-Western Ontario
Scale : 1/1900800 = 30 Mls. to an Inch.
—SIGNS—
No Salt
Salt
Wells
Approximate easterly boundary of the salt area.
LAKE HURON
INTERNATIONAL BOUNDARY
UNITED STATES
NORTH AST.
LAKE ST CLAIR
LAKE ERIE
BRUCE
GREY
HURON
PERTH
WATERLOO
WELLINGTON
LAMBTON
MIDDLESEX
OXFORD
ELGIN
KENT
ESSEX
NORFOLK
SOUTHAMPTON
KINCARDINE
TEESWATER
WINGHAM
GODERICH
CLINTON
BLYTH
BRUSSELS
LISTOWEL
HARRISTON
DURHAM
STRATFORD
ST. MARYS
EXETER
HENSALL
SEAFORTH
MITCHELL
DUBLIN
STAPLETON
PARKHILL
SARNIA
PETROLIA
MOORETOWN
COURTRIGHT
PORT LAMBTON
GLENCOE
LONDON
ST THOMAS
INGERSOLL
WOODSTOCK
NORWICH
TILSONBURG
CHATHAM
DRESDEN
SANDWICH
AMHERSTBURG
OWEN SOUND
MEAFORD
WIARTON
Thames River
Aux Sables R.
Sturgeon R.
Maitland R.
St. Clair River
G.T.R.
C.P.R.

Salt	No Salt
Kincardine	Inverhuron Southampton Port Elgin
Wingham	Teeswater
¾ mi. S.W. of Brussels	Brussels
Seaforth	Dublin Mitchell Stratford
London Glencoe	Tillsonburg Norwich
Pt. Lambton	Comber ? Chatham ?
Sandwich Windsor	Amherstburg ?

The query placed after some of the names indicates a doubt as to whether the borings have been sufficiently deep to reach the salt horizon in these cases. It may be that the salt area extends southward to Lake Erie, including the whole of Kent and Essex, but this can not be asserted. It is claimed that a boring in Orford township, Kent, struck salt 171 feet thick at a depth of 1,510 feet, but the writer could find no definite record of this well. The approximate eastern boundary of the salt area has been indicated on the map which accompanies this report.

Production

The salt production in Ontario since 1900 has been as follows:

Year.	Salt produced.	Value of product.	No. of workmen	Wages paid.
	tons.	$		$
1900	66,588	324,477	243	72,581
1901	60,327	323,058	189	67,024
1902	62,011	344,620	198	76,154
1903	58,274	388,097	208	87,995
1904	55,877	362,621	193	84,682
1905	60,415	356,783	148	68,580
1906	50,414	367,738	151	69,153
1907	62,806	432,936	194	85,935
1908	79,112	488,330	195	93,700
1909	77,490	389,573	176	89,995
1910	84,071	414,978	202	114,056

Imports

The imports of salt into Canada during 12 months ended March 31, 1910, were as follows:—

From	Tons.	Value.
		$
United Kingdom	64,613	256,442
United States	27,885	140,924
All other countries	41,400	67,808
Total	133,898	465,174

The imports of salt products into Canada during 12 months ended March 31, 1910, were as follows:—

—	Lbs.	Value.	Duty.
		$	
Soda (bicarbonate)	5,608,776	52,701	15 to 17½ per cent.
Soda (caustic)	11,686,641	232,843	Mostly free.
Bleaching powder	10,160,238	110,145	Free.
Other products (not complete)	....	88,000	....
		483,689	

No soda or bleaching powder are manufactured at present in Canada.

A GEOLOGICAL TRIP IN SCOTLAND

Pre-Cambrian of Northwest Highlands compared with that of Ontario

BY WILLET G. MILLER

Scotland has been a great mother of geologists. At the end of the eighteenth century Hutton (1726-1797) with his "Theory of the Earth," and his disciple Playfair with the "Illustrations," placed the science on the road which it has since followed. The heroic struggle between the plutonists, as Hutton and his Edinburgh school were called, and the neptunists, or those who sided with the great Freiburg professor, Werner, was a memorable one. Among Scottish geologists who were connected with this controversy may be mentioned James Hall (1761-1832), to whom is due the establishment of experimental research as a branch of geological investigation, and Robert Jameson (1774-1854), who upheld the Wernerian system. Of this period were John Macculloch (1773-1835), an eminent pioneer worker on the pre-Cambrian and author of remarkable maps, and William Nicol (about 1768-1851), to whom the petrographical branch of the science is much indebted. William Maclure (1763-1840), born at Ayr, has been called the "Father of American Geology."

Culag Hotel, Loch Inver, Lewisian Gneiss in foreground, Mts. Canish and Suliven in background.

Then onward through the years there always have been eminent leaders of geological thought among Scotchmen, e.g., Murchison (1792-1871), the founder of the Silurian system, and Hugh Miller (1802-1856), whose writings did so much to popularize geology. To this list may be added the name of the Canadian, Logan (1798-1875), of Scottish ancestry and educated in Edinburgh. Among Scottish geologists still living may be mentioned the brothers Geikie, Sir Archibald and James, the former of whom by his text-books and other writings, has had a greater influence on students of the science than has any other author. Then there are Peach, Horne and other investigators, who have added much to our knowledge of the history of the earth. Most Scottish geologists have resided in Edinburgh and have doubtless received much of their inspiration from the surroundings of the city. Edinburgh is probably unsurpassed in the facilities it

offers to beginners in the study of geology. "On every side of us are incentives to study. Crag and hill rise around us, each eloquent of ancient revolutions, and each a silent witness of the revolution in progress now. At our very gates tower on one side the picturesque memorials of long silent volcanoes, with their crumbling lavas and ashes. On the other lies the buried vegetation of an ancient land, with the corals and shells of a former ocean."[1]

A cynic might say that Scotchmen take to geology for the same reason that they do to theology. In both sciences it is difficult at times to prove that the other fellow is absolutely wrong. This gives opportunity for agument. But whatever be the explanation of the mental attitude of the people towards other sciences, the character of the country has doubtless had much to do with the popularity of geology:—

"O Caledonia! stern and wild,
Meet nurse for a poetic child!"

or, let us add, for a geologist.

The Pre-Cambrian

While Scotland offers classic localities to students of most branches of geology, its pre-Cambrian rocks will appeal strongly to the majority of Canadian students of the science. Our country has a greater expanse of these rocks than has any other land—approximately half of it, or 1,900,000 square miles, being underlain by rocks of this age.

Northwest Highlands

Owing to the importance of a close study of the pre-Cambrian rocks in this country, it is of great value to workers here to have an opportunity of visiting areas of rocks of like age in other countries, especially where they have been studied and mapped in detail. For this reason the writer, while on a trip to Europe during the past summer, spent as much time as possible in the Northwestern Highlands of Scotland, a region which has been studied closely by three or four generations of geologists. It has been mapped in greater detail than has any other pre-Cambrian region in the world, and it exhibits some of the most striking illustrations of pre-Cambrian stratigraphy and structure to be found anywhere.

The success of my visit to the Highlands was due chiefly to Dr. John Horne, F.R.S., of the Geological Survey, who, while I was in Edinburgh, kindly drew up a daily programme for me, so that I might see typical localities of the pre-Cambrian rocks and of their structural relations in the all too brief time I had to devote to the trip.

Itinerary

From Edinburgh I proceeded to Inverness, thence northwestward to Lairg. Here motor stage was taken to Loch Inver, on the northwest coast, where there are striking exposures of the Lewisian, reminding one forcibly of the typical Laurentian gneiss of Canada.

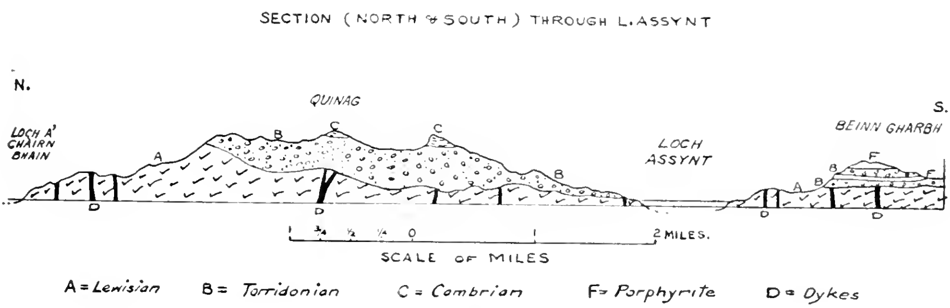
Having examined exposures of the basement rocks at Loch Inver the route was retraced eastward to Inchnadamff and Loch Assynt. Immediately north of Assynt is the mountain Quinag, extreme summit 2,653 feet. At its base is the Lewisian gneiss which is overlain by Torridon (pre-Cambrian) sandstones. The summit is capped by a small outlier of Cambrian quartzite. On the west side the mountain is flanked by precipitous cliffs 500 to 700 feet in height. For a long distance the rocks of the three ages can be distinguished from one another by their colour.

From Inchnadamff a trip was made to Kylesku and Loch Glencoul, where the famous "thrust planes" are to be seen in striking exposures. The character of the thrusts will be gathered from the following:[2] "The most important feature in the geology.

[1] Sir A. Geikie, "Geological Sketches."

[2] See "The Geological Structure of the North-West Highlands of Scotland," Memoir of the Geological Survey of Great Britain, for this and following quotations concerning geology in this paper.

of the Northwest Highlands, which renders this region of surpassing interest to the geologist, is the evidence relating to the terrestrial movements that took place in post-Cambrian time. From a detailed examination of the structures in the field and from certain experimental researches . . . it can be seen that under the influence of horizontal compression, or earth-creep, the rocks in that area behaved like brittle rigid bodies, and were folded over each other, snapped across, piled up and driven westward in successive slices. . . . . The most easterly and perhaps the most powerful of these disruptions, to which the name of "Moine Thrust" has been given, differs from all those to the west in two important points. First, the materials overlying that plane comprise the Eastern Schists—the fourth of the great rock groups referred to . . . secondly, in some instances the strata overlying this (thrust) plane have been driven so far west—for ten miles at least in the Durness area—that they rest almost directly on the undisturbed Cambrian rocks. Hence arise those deceptive sections where there seems to be a normal sequence from the fossiliferous Cambrian zones into the Eastern Schists." The "belt of complication" extends for 120 miles from the north coast of Sutherland to the southern promontory of the Isle of Skye. The following map of the area adjacent to Loch Glencoul illustrates the character of the thrust planes. The point separating Loch Glencoul from Loch Glendhu is composed of Lewisian gneiss, the basement rock, overlain by Cambrian strata. Above the Cambrian is a thrust plane, the Glencoul thrust, and overlying this thrust plane the Lewisian gneiss and



(After Geological Survey of Scotland.)

Cambrian strata are repeated. Above the latter strata is another thrust plane, known as the Moine Thrust, and overlying this thrust plane are the Moine, or Eastern, Schists. There are minor thrusts in this section to which we need not refer. The following diagram of the Glencoul section is a slightly modified copy of one in the memoir of the Geological Survey.

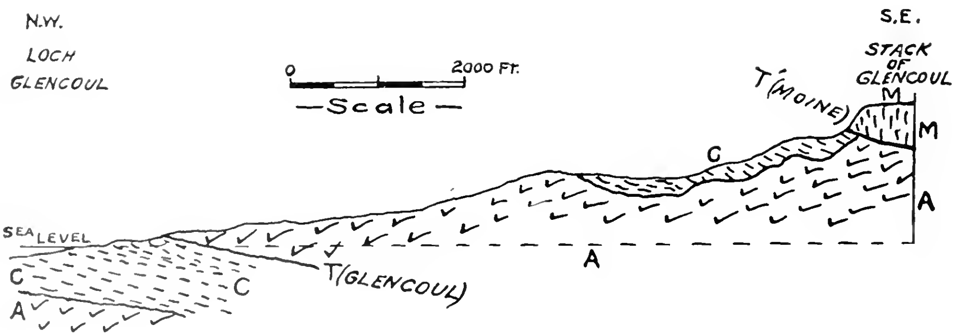
Leaving Inchnadamff, I proceeded southward to Loch Maree, one of the most beautiful lakes in Scotland, in order to examine especially exposures of crystalline limestones with their associated rocks and their relation to the Lewisian. The limestones with their accompanying schists were found to be much like those of the Grenville series of southeastern Ontario.

From Loch Maree I travelled southward to Glenelg, where crystalline limestone and other rocks were examined in Glen Beg.

From Glenelg a steamer was taken to Mallig, thence by railway to Fort William to see the rocks of Ben Nevis. This finished the programme arranged for me and I returned to Edinburgh via Glasgow.

In Scotland, a Canadian is constantly struck with the difference between doing geological work there and in Canada. In the Highlands, on a clear day, the various rock groups on the treeless hills can be recognized from a long way off, while in forest-covered Ontario, for instance, a geologist often cannot see more than a hundred yards ahead, and has to search for outcrops almost yard by yard. Again, in Scotland, even in desolate areas, one frequently has his attention distracted from the rocks to some-

thing of historical or antiquarian interest. For instance, in a lonely glen near Loch Inver a circular opening in the cliffs was pointed out as having been used as a pulpit. "It was grand to hear them singing the Gaelic hymns." On the north side of Loch Assynt are two ruins, in one of which Montrose is said to have been betrayed. Loch Alsh, near Glenelg, was the scene of some of Prince Charlie's exploits, and at the latter place is the ruins of a barracks erected about 1715 to keep the wild Highlanders in subjugation. It is fortunate, probably, that previous to the trip I had time to look up only the geological literature, otherwise I might have had my attention still more distracted from the rocks. Moreover, to discover things for oneself added to the charm of the trip in some ways. Thus, on going to see the limestones in Glen Beg, than which "there are not many Highland glens more attractive," I came unexpectedly on the Pictish towers. It was almost like exploring an undescribed region. "The valley is rendered still more interesting by these remains of Pictish towers which it contains, and which, if not perfect, are still sufficiently entire to explain the structure of these singular buildings. In an antiquarian view they are even more interesting, not only on account of their singularity, antiquity and obscurity, but because they are by much the most perfect, as well as the most accessible, "specimens" of the earliest native architectural remains." Whether these Pictish towers, or burghs, are of Danish or purely native origin, has been disputed. These large circular structures are built of unhewn stone and entirely without cement. Many remains of the towers can still be traced in the Highlands. The masonry is remarkably well laid and the lines of the curvature are beautifully preserved, the form being that of a truncated cone.



Outline of the Geology

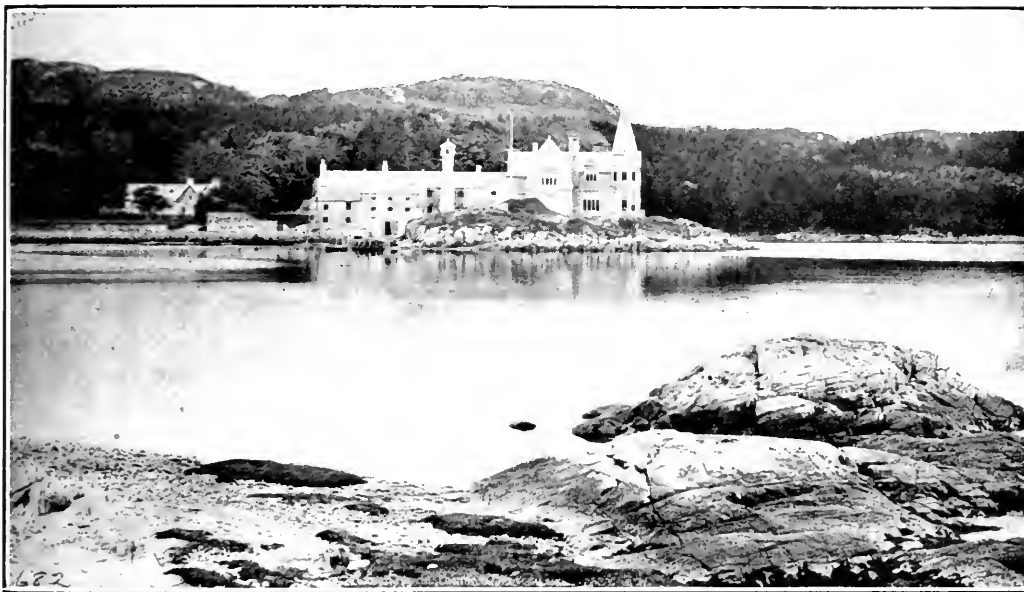
In the opening paragraph of the introduction to the great memoir on the "Geological Structure of the North-West Highlands," Dr. John Horne so briefly and interestingly summarizes the present knowledge of the geology and the history of the work of unravelling the relationships of the rocks, that I may be permitted to quote his words: "In the North-West Highlands of Scotland four great rock-groups are remarkably developed, each characterized by a peculiar type of scenery and illustrating in a vivid manner the intimate relation that exists between geological structure and the evolution of mountain-forms. Each group has impressed its own individuality on the landscape in such a manner as to arrest the attention not merely of the geologist, but even of the casual and unscientific traveller. These four groups are in consecutive order from west to east: 1st the Lewisian or Fundamental Gneiss; 2nd, the Torridon sandstone; 3rd, the Cambrian formation; and, 4th, the Eastern Schists. Ever since the time of Macculloch, at the beginning of the last century, the stratigraphical position and relative age of these rocks have been subjects of animated discussion and, for a time, of keen controversy. Relying on the apparent order of superposition, the earlier observers naturally inferred from the magnificent sections laid bare along the western fjords and on the grand escarpments and dip-slopes of the mountains, that the Eastern Schists follow the Cambrian strata in conformable sequence. But the geological struc-

ture, which seems at first sight so simple, has proved on later detailed examination, to be extremely complicated. The apparent succession has been found to be deceptive, and the superposition, which is undeniable, is now ascertained to be due to great terrestrial displacements, which have no parallel elsewhere in Britain."

Owing to the marked contrast in the lithological character between the three great series of rocks—the grey or pink Fundamental gneiss, the red Torridon sandstone, and the white Cambrian quartzites with the limestones and dolomites—it was possible for the officers of the Geological Survey to trace the several portions of these formations even through extremely complicated structures.

Early Work in Scotland and Canada

Between 1814 and 1824 Macculloch proved the true relationship between the two great series, the Lewisian and the Torridonian. This relationship is like that which exists between the Huronian and the Laurentian of Canada, where work did not begin on the pre-Cambrian till nearly twenty years later. In 1827 Murchison and Sedgwick



Culag Hotel, Loch Inver, with exposure of Lewisian Gneiss.

visited northwest Sutherland. From this time on, during the thirty years or so that Logan and his assistants were working out the structural and age relations of the pre-Cambrian rocks of Canada, the ancient rocks of the Northwest Highlands received much attention, notably from Murchison and J. Nicol. By 1860 the latter had worked out the relationships of the rocks so completely that he is admitted to have "displayed the qualities of a great stratigraphist in grappling with the tectonics of one of the most complicated districts of Europe."

The papers published on the Highland rocks and the controversies concerning them, during the period to which reference has been made, must have been of much interest, and doubtless acted as an inspiration, to Logan and his associates engaged with similar problems.

The Lewisian

The Lewisian or Fundamental Gneiss stretches as an interrupted belt from Cape Wrath to Loch Torridon. Like much of the territory occupied by the Laurentian of Canada, this belt of country is remarkably bare and sterile. Rounded domes and bare ridges, with intervening hollows, follow one another.

The Lewisian system occupies a position in relation to the sandstones and conglomerates of the Torridonian similar to that which the Laurentian and Keewatin do to the fragmental Huronian and Keweenawan series of Canada. In other words, the Torridonian rests on the Lewisian with strong unconformability. Moreover, like the typical Laurentian, the Lewisian rocks are characterized by banded and foliated structures.

The Geological Survey of Scotland has arranged the Lewisian in two groups: (1) a Fundamental Complex, composed mainly of gneisses that have affinities with plutonic rocks, and, to a small extent, of crystalline schists and limestones which are probably of sedimentary origin; (2) a great series of igneous rocks intrusive in the Fundamental Complex in the form of dikes and sills.

Group (1) is very similar to that which was embraced under the name Laurentian by Logan, whose classification has been used up to comparatively recent times in Canada. The gneisses of Scotland correspond to the typical banded gneiss of Logan's Laurentian, while the crystalline limestones can be compared with his Grenville series, which was placed by him in the Laurentian system. During recent years in Canada the name Laurentian has been used in a more restricted sense.

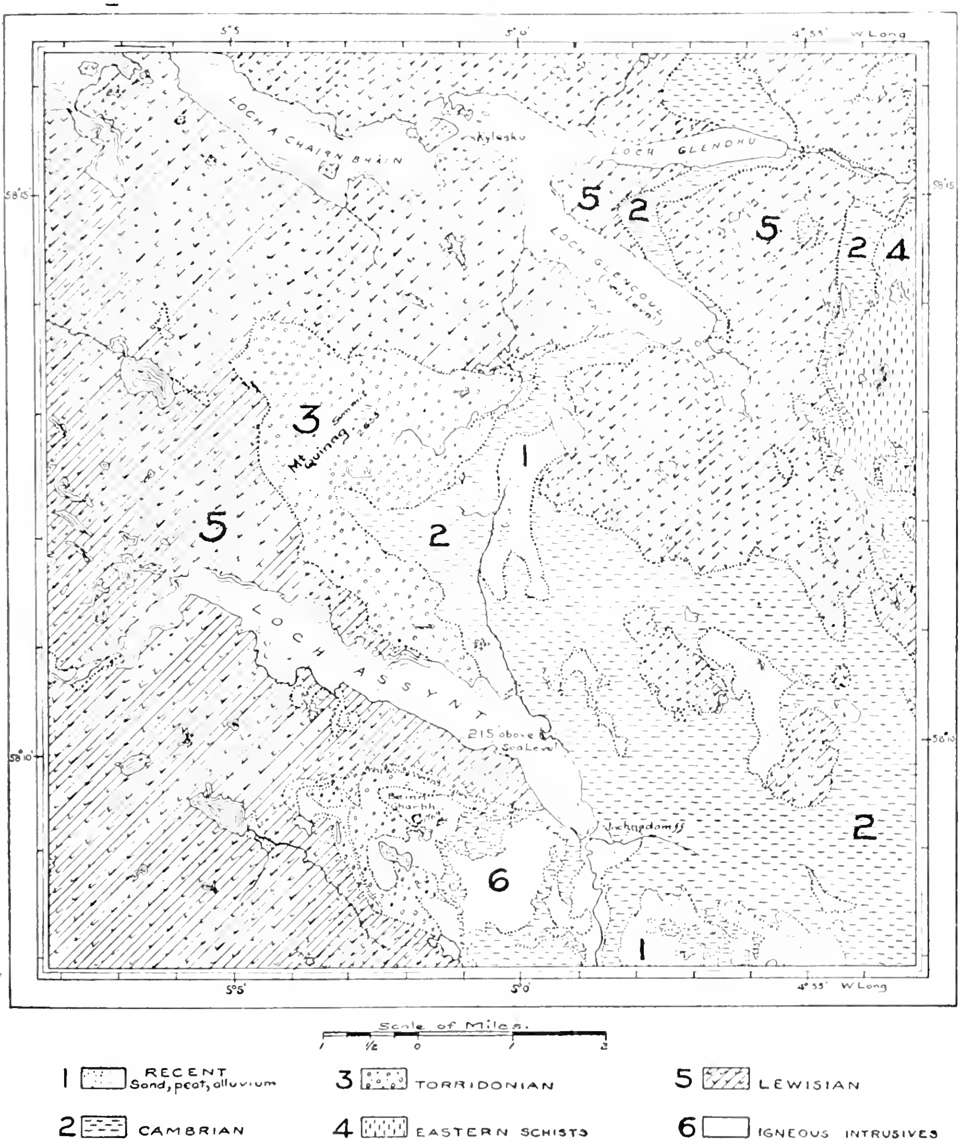
Sediments in Lewisian

In the memoir to which reference has been made, Dr. Horne says: "If the stratigraphical relation of the altered sediments of the Lewisian gneiss to the gneisses that have affinities with the plutonic rocks could be definitely ascertained, it would possess much geological interest, in view of the antiquity of these sediments and the relative ages of the original types of gneiss. There is no clear evidence that these types are intrusive in the former, but, in certain places, the two are so intimately associated as to suggest that the rocks of igneous origin may have been injected into those of sedimentary origin. On the other hand, there is undoubted proof that, north of Loch Maree, the altered sediments rest on a platform of gneiss and are locally overlain by gneiss with basic dikes, the superposition of the gneiss on the sediments being there due to folding and thrusting."

The sediments, consisting of the crystalline limestones and associated rocks, are much like the sediments in the Keewatin-Laurentian complex of southeastern Ontario. Mr. Cyril W. Knight and the writer have expressed the opinion that the older crystalline limestones here represent marine precipitates which have been deposited on the surface of the Keewatin lava flows. Then the rocks having been subjected to stresses, in many localities, a complexity has been produced which is difficult to unravel. In so far as the writer could see, a similar relationship may exist between the crystalline limestones and some of the other Lewisian rocks of Scotland.

The igneous gneisses of the Fundamental Complex of Scotland represent plutonic types, while the Keewatin rocks of Canada, our oldest rocks, are volcanic. This difference may be accounted for by the fact that the period of denudation prior to the deposition of the Torridonian sediments was more prolonged than was the period of denudation in Canada prior to the deposition of the Huronian sediments, which do not seem to be represented in the Northwest Highlands. In this Scottish region the surface igneous rocks have been eroded and the underlying plutonic rocks have been exposed, while in Canada, denudation did not go far enough to remove the surface material, now represented by the Keewatin. "It is remarkable that their (Torridon sandstones) enclosed pebbles include pieces of quartzite, which show contact alteration, spherulitic jaspers that have been formed by the silicification of liparites, and spherulitic felsites which closely resemble those of Uriconian age in Shropshire. As these fragments have all been derived from formations that are now not visible anywhere in the western part of the Counties of Sutherland and Ross, they furnish further evidence of the denudation of the Archean plateau in the pre-Torridonian time."

In other words, the quartzite pebbles show that pre-Torridonian fragmental series, probably to be correlated with the Huronian of Canada, and the liparites and felsites show that a series of volcanic rocks have been removed by denudation, bringing to the



Geological Map of the area in the vicinity of Lochs Assynt and Glencoul, Sutherlandshire. The map shows the areal distribution of the pre-Cambrian (Lewisian and Torridonian) and the Cambrian, together with the two thrust planes at Loch Glencoul. (After coloured map of the Geological Survey of Scotland).

pre-Torridonian surface the plutonic types of the Fundamental gneiss. The felsites and other volcanic types may represent a series comparable in age with the Canadian Keewatin.

Grenville and Keewatin

The following quotations, taken from different pages of the Memoir, will bring out more clearly the resemblance of the sedimentary material in the Lewisian gneiss to the Grenville series of Canada. Moreover, it will be seen that the sedimentary material is associated with hornblende or chlorite schist, some of which may be altered basic lava. Associated with the hornblende schists are "quartz-magnetite granulites resembling the rocks of the Penokee iron-bearing series described by Irving and Van Hise." The hornblende schist, in so far as the writer knows, has not been proved to be intrusive into the crystalline limestone and associated sediments, but it is said that it "appears to have been injected along the margins" of the sedimentary bands. Since the hornblende schist is not known to be intrusive, one might be pardoned for hazarding the opinion that the relationship between at least some of the hornblende or chlorite schist on the one hand, and the crystalline limestone, iron formation and other sedimentary material, on the other, is like that between the Keewatin and the iron formation and other sedimentary material in Ontario and the Lake Superior region in general. In any case it may be said that the Scottish rocks, in character and in their association, are strikingly like those of the last mentioned region.

"In Gairloch the chief belt of these altered sediments extends for seven or eight miles . . . . Its width is about a mile and a quarter, half of which is occupied by bands of hornblende-schist or hornblende chlorite schist. Consisting for the most part of a fine-grained brown mica-schist, it contains also various bands of limestone, graphite-schist and quartz-schist or quartz-magnetite-schist."

"There is no proof of the intrusion of the gneissose rocks of the Fundamental Complex into the supposed sediments, nor yet of the unconformability of the latter on the former. In certain places bands of marble and of kyanite-gneiss lie within gneisses of common type in the complex, and pass gradually into them."

"Great intrusions of igneous material, most of them now in the form of hornblende-schist, appear also to have been injected along the margins." And further: "Their (the hornblende schists) general uniformity of composition and texture and the rarity of inclusions in them which can be regarded as detached fragments of other rocks, or distorted amygdules, are hardly consistent with the supposition that they are altered contemporaneous lavas, but, on the other hand, they have nowhere been observed to transgress the sediments in any clear section. In general they are more finely foliated than most of the dikes either near them or elsewhere."

"On the southeast side of Shieldaig a band of micaceous schist, 120 yards broad at its greatest width, often calcareous and with outcrops of marble, emerges from beneath the Torridon rocks."

"It is interesting to compare the rocks of this and the preceding group (quartz-schists) with certain rocks found in the Penokee iron-bearing series. . . The rocks of this series include (1) cherty carbonates; (2) ferruginous slates and cherts; and (3) actinolitic and magnetitic slates. The quartz-hornblende rocks and the quartz-magnetite rocks from the Loch Maree area have decided affinities with the actinolitic and magnetitic slates of Van Hise. Both groups of rocks contain the same minerals and possess to a certain extent the same structures."

The altered sediments on the northeast side of Loch Maree "are associated with broad outcrops of hornblende-schist, and consist for the most part of mica-schist, graphite-schist and limestone, with bands which may represent altered quartzite and chert. The broadest development of these rocks stretches from Letterewe to Fasagh and may be called the Furnes belt. Its length from northwest to southeast is about five miles, and its greatest breadth, including various outcrops of hornblende-schist, nearly three-quarters of a mile."

"Near Kerrysdale chloritic schists occur on both sides of the more northwesterly of the two hornblende-schists. . . . These schists merge into hornblende-schists. . . . Small crystals of magnetite and calcareous spots and streaks appear more commonly in the chloritic than in the hornblendic schists. The chloritic schists usually effervesce freely with hydrochloric acid, even when no carbonate can be recognized macroscopically, and one of the calcareous streaks near Auchtercairn is a good limestone."

"A quartz-magnetite-schist, mixed with limestone and calcareous chlorite-schist, is seen in various places at the northeast side of the thick hornblende-schist whch runs northwest from a point 300 yards southwest of the outlet of Loch Bad an Sgalaig in the Gairloch district.

"The quartz-schists in both districts may possibly represent altered cherts, but the present resemblance of certain portions of them to cherts is perhaps rather the result of deformation. In some exposures northeast of Loch Maree more than 30 thin laminæ may be counted in the thickness of a quarter of an inch. Each of them was not improbably broader originally but has been dragged out and thinned."

It may be that some of the Canadian banded gneisses which have been called Laurentian are in reality older than the Keewatin. If this is the case, then these gneisses represent the surface over which the Keewatin rocks have flowed, and the crystalline limestones and other sediments have been deposited on the surface of the lavas or interbedded with them. If such be the case in Canada and the Lewisian gneiss is not intrusive into the crystalline limestones and schists of the Highlands, then the relationships and resemblance between the oldest rocks of Canada and the Highlands is similar.

On the other hand, if the Lewisian is intrusive into the crystalline limestones and associated schists, the relationship is exactly like, in so far as is known, that which the Laurentian granite and gneiss bears to the Keewatin and Grenville rocks of Canada.

Group (2) of the Lewisian

Group (2), the igneous rocks intrusive into group (1), corresponds in a general way with certain post-Laurentian intrusive rocks of Canada, viz., certain granites and so forth which are pre-Keweenawan in age.

The Torridonian

There is no means of definitely determining whether the Torridonian of Scotland corresponds to the Huronian or to the Keweenawan of Canada. It has been correlated with the Keweenawan by some writers on account of its reddish or brownish colour and degree of consolidation. But rocks that look alike, especially in the pre-Cambrian, are frequently quite different in age. Moreover, in the writer's opinion, much of the Torridonian shows as great a degree of consolidation as does some of the Huronian. In fact, in certain localities, the Torridonian has a schistose structure.

"The great bulk of the formation consists of more or less coarse-grained arenaceous sediments in the form of felspathic grits and sandstones (arkose), with occasional thin intercalations of fine-grained micaceous shale and sandstone. Coarse angular breccia occurs as a local base, and numerous bands of pebbly grit, conglomerate, and scattered pebbles are found at different horizons, while the whole series is characterized by false bedding and other signs of current action." The prevalent features of the series are the uniformity of composition and fresh appearance, and the regularity and generally undisturbed character of their disposition.

"The base of the Torridonian series is usually formed of a conglomerate or breccia, sometimes exceedingly coarse in texture, and derived from the Lewisian rocks in the immediate vicinity."

"The pebbles that occur so abundantly throughout the arkose series afford, however, the strongest proof of the foreign origin of most of the Torridonian sediments. . . . It may be sufficient to state here that they (the pebbles) include examples of sedimentary, metamorphic and igneous rocks which are not found within the Lewisian area, and suggest the existence of a pre-Torridonian sedimentary and eruptive series as the source of the coarser materials of the Torridonian formation."

While the writer does not think that the lithological resemblance of the Torridonian to the Keweenawan is sufficient evidence on which to base the correlation of the one with the other, there is other evidence to the effect that the two series should probably be correlated. (a) On a preceding page it has been shown that certain pebbles, quartzite and so forth, in the Torridon conglomerate, prove that a sedimentary series has been removed before the deposition of the Torridonian. This series that has been eroded may correspond to the Huronian of America. If so, then the Torridonian may be considered to correspond to the youngest of the pre-Cambrian sedimentary series of America, the Keweenawan. (b) The intrusive rocks of group (2) of the Lewisian do not cut the Torridonian. They bear a relationship to the latter like that which certain granites, and so forth, of America, which cut the Huronian, bear to the Keweenawan.

The following table will make clear the suggested relationships:

1. Canada—

A. Keweenawan.

B. Huronian with intrusives.

C. Keewatin-Laurentian Complex (Laurentian granite and gneiss, Keewatin greenstones, etc., together with crystalline limestone, iron formation, etc.)

2. North West Highlands.

A. Torridonian.

B. Intrusives (of group (2) of Lewisian). A fragmental series consisting of quartzite, etc., has been removed by denudation prior to deposition of Torridonian.

C. Lewisian, Fundamental Complex (gneiss, hornblende and chlorite schists, crystalline limestone, iron formation, etc.)

After the eruption of the dikes and sills of group (2) of the Lewisian, and long before the deposition of the Torridonian rocks, the whole region of northwest Scotland was subjected to terrestrial stresses which affected both the Fundamental Complex and the intrusive masses that penetrate it.

Glacial Origin of Conglomerate

It is interesting to note that a glacial origin was suggested formerly for the Torridon conglomerate, as it has been suggested in late years for Huronian conglomerate of Ontario. "The mammilated contour so characteristic of the plateau of Lewisian gneiss was attributed by Sir A. Geikie in 1880 to the action of land-ice, and he compared the overlying breccia of Torridon sandstone age, that fills up the hollows and buries the rounded domes of rock near Gairloch, to moraine stuff."

In the final memoir by the Geological Survey on the Northwest Highlands, 1907, the theory of the glacial origin of the Torridon conglomerate is dropped. "The basal breccias which often flank the buried mountains (Lewisian below Torridonian), are, as already explained, of the nature of scree material. They consist of fragments of the local rocks embedded in a sandstone matrix. The conglomerates, on the other hand, are probably torrential deposits brought down from a district very different in geological structure from that of the area in which Lewisian gneiss occurs."

The fragments of rock in the Torridon conglomerate and breccia have frequently come from a considerable distance. "In one instance, on the north side of Loch Maree, it has been observed that blocks in the conglomerate have come from the hornblende-schist ridge of Ben Lair, and may have travelled a distance of three miles."

Absence of Ore Deposits in Highlands

Considering the importance of the ore deposits in the pre-Cambrian of the Lakes Huron-Superior region, the absence of valuable deposits in the Highlands at first seems remarkable. If we bring to mind, however, the difference between the pre-Cambrian of the two regions, the non-economic importance of the Highland rocks is not so much to be wondered at. The Keewatin series is not known to occur in the Highlands, and, if it does, the outcrops are comparatively insignificant. In this series in America are found the Vermilion and other important iron ranges. The Animikie or Upper Huronian is likewise absent in Scotland, while in the Lake Superior region the great

Mesabi iron deposits occur in it. Moreover, if there are rocks in Scotland similar to the quartz-diabase of Cobalt or the norite of Sudbury, which have been the ore-bearers in these two important mineral areas, they are of small volume. The copper deposits of Michigan are found in the Keweenawan, but the Torridonian has not been rendered of similar economic importance by basic igneous rocks.

Cambrian and Eastern Schists

Little need be said concerning the Cambrian except that it rests unconformably on the Torridonian and its lower beds represent the Olenellus zone. One of the most puzzling points that the early workers in the field had to deal with was the relation of the Cambrian to what are known as the Eastern or Moine Schists, the fourth great group of the Highlands. Later work has shown that the superposition of the highly metamorphosed rocks on the Cambrian has been brought about, as has been said on a preceding page, by thrust.

The character of the Eastern schists and the knowledge possessed of their age relationships will be understood from the following: "Only a brief reference need be made here to the Eastern Schists that appear to the east of the Moine Thrust-plane. Excluding the belt of mylonized rocks (ground-up rocks), usually found in association with that displacement, this group comprises flaggy, quartzose schists with muscovite, quartz-biotite, granulites, and garnetiferous muscovite-biotite-schists, which together evidently represent an altered sedimentary series. . . . These rocks have been the subject of much discussion. They were once regarded as portions of the oldest or Azoic architecture of the country. Murchison considered them to be a metamorphic series of mainly sedimentary formations, later in date than the Lower Silurian (Cambrian) limestones and quartz-rocks which underlie them, and into which they seemed to pass downward in a conformable succession. The detailed study of them by the Geological Survey has thrown considerable light on their composition and structure, but the problem of their age and origin has not yet been completely solved. . . . When the rest of the Highlands lying to the east of that belt has been surveyed, it may be possible to offer some more definite opinion as to the stratigraphical relations and history of these rocks."

While rocks of diverse age and origin are included under the name Moine Schists, "which together evidently represent an altered sedimentary series," a person familiar with the pre-Cambrian of Canada will be inclined to ask himself whether much of this altered sedimentary series does not represent a group of rocks that, in age, lies between the Lewisian and the Torridonian. If this is the age relation of some of the schists, they occupy a place in the geological column similar to that of the Huronian of Canada, which lies between the older Laurentian-Keewatin complex and the younger Keweenawan. In the description, given above, of the Torridonian, it was said that the pebbles of quartzite and other rocks, "derived from formations that are not now visible anywhere in the western part of the counties of Sutherland and Ross," are found in the conglomerates of the series, showing that an older sedimentary series has been removed before the deposition of the Torridonian. Similarly in Canada it is found in some localities that the Huronian has been removed before the deposition of the Keweenawan on the Laurentian-Keewatin complex.

The relationship that has been observed to exist, in two or three localities, between the Lewisian and the Eastern Schists, will be seen from the following: "More recent work, however, between Stromeferry and Loch Alsh has led Dr. Peach to the belief that the Moine Schists in that district rest unconformably on gneisses of Lewisian type. He has found what he regards as a conglomerate locally developed at the base of the Moine Schists and overlain by a definite order of succession among the schists analogous to that in the Diabaig group of the Torridon sandstone. . . . It would thus appear that at least some of these rocks existed as crystalline schists before they had reached their present position." Schists in one locality in Skye possess characteristics from which it might be inferred that they represent a sedimentary series older than the Torridonian. "These schists represent what were originally false-bedded grits and sandy and gritty shales."

THE MINING LAW OF ONTARIO

BY S. PRICE, Mining Commissioner

General Remarks

The mining lands already taken up in Ontario form but a very small fraction of the total area of the Province. Less than one million of our total 126 million acres have been patented and leased for mining purposes, and less than 26 million acres have been alienated by the Crown for all purposes. More than 100 million acres, or over four-fifths of the total area, still remain vested in the Crown and open, with but trifling exceptions, to the prospector and miner.

Laws regarding the disposition of public lands by the government and the exploration and acquisition and use of them by the individual for mining purposes, differ greatly in different countries and have varied much from time to time in our own Province; and probably no law upon the subject anywhere has ever had the unanimous approval of those working under it, for individual opinions and points of view differ even more widely than the laws. Poor prospectors and rich capitalists, men with little and those with large experience, those who want to find something to develop and those who desire merely to get something to sell, the miner who wants to work the land for the valuable mineral he expects it to produce and the speculator who desires only to hold it while neighboring development increases its value, can hardly be expected to view matters in the same light or to desire the same kind of a law; nor is the interest of any of them always identical with the paramount interest of the community as a whole to which the property in the first place belongs; though doubtless in a country with the mineral promise and the large extent of minerally unexplored territory that Ontario possesses, a liberal encouragement of individual enterprise such as will promote discovery and cause development must in the end be the best policy.

The Features of a Good Law

As to what some features of a good mining law should be, there can be little room for controversy. Simplicity in the requirements for the acquisition and holding of claims, and certainty and security in the miner's holding when these requirements have been complied with, may be set down as of first importance. It is also pretty generally agreed that some provision such as working conditions or periodical payments designed to bring about development and prevent the blanketing and holding of lands in idleness or for merely speculative purposes, should form a part of every mining law. Simple machinery for determination of disputes and speedy finality in litigation, are other very important matters from the miner's point of view. Uniformity of laws, which, it has been suggested, might be secured throughout Canada, would also, if it could be accomplished, seem a consummation to be wished, and perhaps not the least of its benefits would be the greater stability which would likely result from it.

Discovery and Title

Among the points upon which laws and opinions differ, two appear most prominent: (1) Whether or not in the taking up of a claim discovery of valuable mineral should be insisted upon, and (2) Whether absolute title in fee simple or only a lease or conditional title or right of occupancy should be given to the claim-holder.

The two points seem to a certain extent correlative—grant of absolute title going more or less logically with the requirement of discovery of valuable mineral, and lease or conditional title or right of occupancy with its non-requirement. Discovery is supposed to show, or to be some indication, that the lands are valuable for mining purposes, and that they will in the natural course be so used, and is therefore some justification for an absolute grant under a statute authorizing the disposal of lands for those purposes. With such a justification lacking, the reasonable thing to do would seem to be to give only such a limited title or right of holding as will ensure or make it likely that

the lands will not be held without being used for the purposes for which they were taken up. The different systems of mining laws have, at all events in general, followed these distinctions. For instance, in the United States, in British Columbia, and for some time past in Ontario, discovery has been required (though not very consistently enforced), and absolute title in fee simple has been given upon completion of a certain amount of development work and payment of what would, if the land were really valuable for mining, be a very insignificant price per acre; while in Nova Scotia, in Mexico, and in Australia, discovery is not exacted, and only leases, titles dependent upon periodical payments, or rights of occupation upon working conditions, are given to the claim-holder. There is, of course, nothing to hinder combination of the requirement of discovery with the limited or conditional character of title (as seems in fact to have been the general rule in miners' customs), or the non-requirement of it with the granting of title in fee simple (as was at one time the case in Ontario), undesirable though the latter may be.

The requirement of discovery would seem to be the ideal principle for dispos'ng of public lands for mining purposes, as under it the law is able appropriately to reward, and as far as possible retain the reward for, the prospector who has conferred a public benefit by bringing to light the hidden resources of the country, and this should encourage prospecting and lead to the opening up of valuable mineral. The great difficulty is to enforce the requirement and to make it operate fairly. It can hardly be denied that, with the exception of a few years during the height of the Cobalt excitement when government inspection was systematically carried out, the law of discovery in Ontario as well as in other places has been a good deal of a failure. The most, perhaps the only, effective method of enforcing it is by having a competent government official make an inspection of each claim. That this was of great benefit in the Cobalt district I think no one acquainted with the circumstances can seriously doubt. To carry it out in less rich and compact mineral regions is a matter of vastly greater difficulty, and perhaps the need is not so great. In response to what appears to have been the desire of the majority of the prospectors and miners of the Province inspection, except in disputed cases, has for the past few years been entirely withdrawn, and the effectiveness of the requirement of discovery has as a consequence been infinitely lessened. Some opinions would abolish the requirement entirely; others would allow claims to be taken up and held on working conditions without it, but would insist upon discovery being made before issue of patent. A requirement so long existing and so widespread, having its origin in the earliest rules and customs of miners themselves, can hardly be without virtue; but the other requirement, as old and probably more general, that a claim-holder must continue to occupy and work his claim or lose his right to it, has perhaps on the whole been the more important and beneficial of the two. The substitution, as in Mexico, of payments of money for performance of work is a variation which finds favor with some who would alter the present system.

History of Ontario Law

Ontario did not, like so large a part of the United States, derive its mining laws from an influx of miners bringing in their rules and customs with them. In our early mining history, going back to about 1845, mining lands were disposed of under Order in Council, at first specific for each case, afterwards crystallized into general regulations. Under these many large areas were granted in fee simple at a small price per acre.

The first legislation, The Gold Mining Act of 1864, (27-28 Vic. Can. Cap. 9) related only to gold mining and did not, as to other minerals, supersede the regulations.

After confederation, The Gold and Silver Mining Act of 1868 (31 Vic. Ont. Cap. 19) was passed by the Ontario Legislature. This followed in the main the provisions of The Gold Mining Act of 1864, but applied to silver as well as gold.

Both these Acts provided for the establishment of mining divisions, and for an officer to preside over them to record claims and determine disputes. The size of claims was very small and varied according to circumstances. A license was necessary, and

the claim had to be staked out by planting a picket at each of the four corners. The title given was merely a right to occupy and work, and leaving the claim unworked for a space of 15 days or more forfeited it.

General Mining Act of 1869

In 1869 was passed The General Mining Act of 1869 (32 Vic., Cap. 34). It superseded the previous Acts and applied to all kinds of minerals. The mining-division provisions were continued with some changes, but with them were enacted provisions for disposing of mining locations of 80, 160 or 320 acres. These might be purchased at $1 an acre, neither discovery nor working conditions being required; nor was it necessary to stake out the land before application.

This Act continued until 1890 with only one change—raising the price per acre in 1886 from $1 to $2. In 1890 (by 53 Vic., Cap. 9) an amendment was made allowing a location of 40 acres as well as one of 80, 160 or 320, and in 1890 also was passed The Mining Operations Act (53 Vic., Cap. 10) enacting rules for safety in the working of mines.

The Amendments of 1891

In 1891 (by 54 Vic., Cap. 8) amendments were made requiring for the first time, so far as statutory enactment was concerned, the performance of development work upon mining locations (as distinguished from mining claims in mining divisions), the work being required to be done during the seven years immediately following the issue of the patent. It was also provided that instead of a patent in fee simple a lease for 10 years might be obtained for a mining location, the lessee to have at any time during the term the right to become purchaser.

In 1892 all former Mining Acts and amendments were repealed and a new Act called The Mines Act, 1892 (55 Vic., Cap. 9), was passed, some new features being added, and the Mining Operations Act of 1890 incorporated.

In 1894 (by 57 Vic., Cap. 16) and 1896 (by 59 Vic., Cap. 13) a number of amendments were made, which are not important for the present purpose.

"Discovery" introduced in 1897

In 1897 (by 60 Vic., Cap. 8) very important changes were again made, and the Acts were consolidated and carried into the Revised Statutes of 1897 (Cap. 36). Discovery of "valuable ore or mineral" was for the first time (by statutory provision) required as the foundation for a mining location, an affidavit of discovery being required to be filed with every application. As to mining claims in mining divisions, the right to take them up was also expressly limited to licensees who "discovered a vein, lode, or other deposit of ore or mineral"; a discovery post was required as well as corner posts, and the form and size of the claim were changed so that instead of being composed of 10 acres laid out along the course of the vein it was to be a square of 22½ acres laid out with boundaries running north and south and east and west, and in filing the claim an outline sketch or plan and particulars much as at present were required.

Again in 1898 (by 61 Vic., Cap. 11), important amendments were made. It was for the first time provided that the holder of a mining claim in a mining division might obtain a patent or lease (at the price per acre charged for mining locations) after performing the prescribed development work for two or three years according as the claim was a square of 22½ acres or a square of 40 acres, the option of making it the latter being now given. The working conditions on mining claims were made five months of one man's time or its equivalent in every calendar year, the old provision requiring continuous working (barring intervals of less than 15 days and any time allowed as close season) being thus replaced.

In 1899, (by 62 Vic. (2), Cap. 10) important amendments were again made, the main feature being a new plan for the taking up of mining land. It was provided that in unsurveyed territory not valuable for pine timber a prospector, after obtaining a license might, under regulations, stake out not more than two mining locations of 40

acres each in a year, and might hold them for two years subject to an expenditure of \$3 per acre of actual mining work the first year and \$7 per acre the second year, after which he was to complete his application as in the case of ordinary mining locations. This Act also increased the number of years' work required to obtain patents for mining claims from three and two to four and three respectively, and changed the amount of work required on them each year from five months' work to \$150 worth of work, computed at \$2 per man per day, and provided that when the amount of work required for a patent had been done no further work would be necessary, thus putting them upon somewhat the same basis as to working requirements as mining locations, except that in the case of mining claims the work had to be done before patent and in the case of mining locations after patent.

Again in 1900 (by 63 Vic., Cap. 13), more changes were made. Royalties, before provided for, were declared to be abandoned; provisions were made (to go into force by proclamation, but never enforced) for exaction of what were called license fees on nickel ores exported to be refined outside of Canada; provisions were also enacted for requiring the raising of a specified amount of iron ore on locations and claims shown to be valuable for iron; an appeal (within 20 days) from the decisions of Inspectors of mining divisions to the Commissioner of Crown Lands was provided for; and the rules and provisions respecting the operation of mines were amended and recast.

In 1905 (by 5 Edw. VII., Cap. 9), further amendments were made, the most important being that leases only (and not patents) were to be granted in forest reserves.

Three Methods of Acquiring Land

Pausing to consider the state of the law just prior to the passing of The Mines Act, 1906, it will be observed that three distinct modes of acquiring mining lands were authorized, two of them differing from each other in almost everything required to be done:—

(1) Mining locations of 40, 80, 160, or 320 acres might, in territory outside mining divisions, be applied for on discovery of valuable ore or mineral without previous staking out and without license, and a patent might be obtained at once (a survey being necessary, however, in unsurveyed territory) by paying \$2 to \$3.50 an acre according to situation, development or mining work of \$1 an acre being required in the first two and in each of the next five years (or the equivalent in less time) after the issue of the patent; or, for \$1 an acre down and 15 to 30 cents an acre according to situation each subsequent year, a lease subject to the same working conditions might be had, and this might afterwards be converted into a patent.

(2) Mining locations of 40 acres might, in unsurveyed territory (not valuable for pine) outside mining divisions, be staked out, under regulations, by a licensed prospector and held for two years by doing mining work of \$3 an acre the first year and \$7 the second, after which a patent or lease might be applied for as in the case of other locations.

(3) Mining claims of 22½ or 40 acres might, in mining divisions, be staked out by a holder of a miner's license on discovery of a vein, lode or other deposit of mineral in place and recorded within 30 days after staking, and might be held by the staker or his transferee by doing \$150 work each year for four years on a 40-acre claim, or three years on a 22½ acre claim, or the equivalent in less time, after which no further work was required, and a patent or lease at the same rate per acre as in the case of mining locations might be obtained if desired.

The provisions relating to mining divisions, unimportant and pronounced to be a failure though they were for many years, came, in 1897, upon the establishment of the Michipicoten mining division, and again, in 1905, upon the establishment of the Temiskaming mining division (then including the Cobalt district), into very great importance. The power of supplementing the provisions of the Act by Orders in Council was extensively used, and all provisions relating to mining divisions were published in the form of regulations, additions and amendments being made thereto by Order in

Council from time to time, among the most important of which were the provisions added in 1905 for inspection of claims and more effective enforcement of the requirement of discovery. A distinct set of regulations had also been made for the taking up of locations under the plan (the second above described) introduced in 1899.

Up to 1906 all questions and disputes as to claims or interests under the Act or regulations were dealt with in the ordinary course of departmental administration without resort to any special officer or to the Courts.

The Mines Act, 1906

In 1906 all prior Acts and all regulations made under them were repealed, and a new Act, known as The Mines Act, 1906, (6 Edw. VII., Cap 11), was passed. It adopted the principle of one law for the Province, and followed in the main, though with many alterations and additions, the provisions formerly applicable to mining divisions. It provided for the division of the whole Province into mining divisions and the establishment of local recording offices in all important mineral districts, licenses being required and being made good throughout the Province. The requirement of discovery was retained, with a stricter definition and a better system of inspection for enforcing it. The working conditions were altered, especially as to the time for commencing their performance, and the size of claims was made more uniform. The granting of absolute title was continued much as before, the price being made $3 an acre in surveyed and $2.50 in unsurveyed territory, but the granting of leases (except in forest reserves) was dropped, and it was made compulsory to apply for a patent within 3½ years from the date of recording. For the more convenient and speedy determination of disputes and to avoid as far as possible suspicion of political influence in the disposition of claims, the office of Mining Commissioner was established, and an appeal given to the High Court in all important cases. Working permits, giving exclusive rights for limited periods without discovery, were also provided for, but since the withdrawal of inspection these have been little used. The Act also contained provisions dealing with placer mining and quarry claims and with petroleum, gas, coal and salt, and it included, as before, rules and regulations respecting the operation of mines.

In 1907 (by Edw. VII., Cap. 13) extensive amendments were made, having chiefly for their object the better carrying out of the intention of the Act of 1906, and remedying defects which it was found to have. It was made clear, as had been intended in 1906, that a second licensee should not be entitled to stake over a prior claim while the latter subsisted; and, to prevent blanketing as a result of this rule, it was provided that unauthorized staking, and staking without recording, should disqualify the staker, and that disputes might be entered against invalid claims. It was also provided that prospectors, while actively following up indications, might protect their operations by prospecting pickets.

The Mining Act of Ontario

In 1908 a complete revision and consolidation of the Acts of 1906 and 1907 took place (in the course of the work of the Statute Revision Commission), the new Act being called The Mining Act of Ontario (8 Edw. VII., Cap. 21). The provisions were rearranged in simpler and more systematic form and many of them entirely recast. Minor alterations and additions as to procedure and otherwise were made, but there was no change in the general policy of the Act. The most important alteration was the abolition of what was known as the close season (15th November to 15th April), which had formerly been excluded in computing the time allowed for performing the first instalment of work.

In 1909 (by 9 Edw. VII., Cap. 17; and Cap. 26, s. 31), and again in 1910 (by 10 Edw. VII., Cap. 26, s. 35, 45), slight amendments were made; those of 1909 relating chiefly to the operation of mines, and those of 1910 to reports of work and certificates of performance of working conditions.

The Premier of British Columbia is said to have claimed some time ago as the chief virtue of his administration of mining affairs, that he let the law alone long

enough for people to find out what it was. Ontario during the last twenty years can boast little of that virtue. From 1890 to 1900 the changes were frequent and extensive, and many of them fundamental. Since then the one radical change has been that of 1906, but less important ones have been numerous. It is interesting, however, to note that notwithstanding the many changes, much of our earlier legislation has persisted even to the present time. This is perhaps only an illustration that many of the conditions and difficulties with which all mining laws have to deal remain always the same.

The Present Law

The present Ontario law may be briefly outlined as follows:—

(1) Anyone over 18 years of age who takes out a miner's license may prospect for minerals upon Crown lands, or lands of which the mining rights are reserved to the Crown, and may take up, work and acquire title to a specified area by making a discovery of valuable mineral, staking out and recording a claim, performing and filing proof of the prescribed development work, obtaining a survey if in unsurveyed territory, and paying a small price per acre; patent being given in fee simple upon the completion of these requirements.

(2) The claim or any share or interest in it may at any time be sold or transferred to another licensee, and transfers, agreements and other instruments executed by the recorded holder may, and to ensure preservation of priority must, be recorded, the recording office being the repository of title prior to patent, much as the Registry or Land Titles Office is after patent.

(3) The validity of every claim is open to dispute for a limited time after recording, but when this time has passed a certificate of record may be obtained, and on satisfactory proof of performance of work a certificate may also be obtained for that, and these certificates, in the absence of fraud or mistake, are conclusive evidence of the performance of the requirements of the Act.

(4) Questions and disputes arising under the Act, either between individuals or between an individual and the Crown, are adjudicated by the local Recorder or by a special officer called the Mining Commissioner, subject to appeal in important cases to the High Court.

(5) Rules and regulations are prescribed for the operation of mines (whether on patented or unpatented lands) looking to the safety of employees and the protection of the rights of other miners and for the collection of statistics.

All these matters are covered by the Mining Act, and placer mining, quarry claims and operations for petroleum, gas, coal and salt are also provided for. Legislation by Order-in Council, as to which so much complaint was at one time made, is not resorted to. There are no rules or regulations, even for procedure, except those contained in the Act; though in the setting apart of mining divisions, and for the withdrawal of lands from sale, and the extension of time for performance of work in specified districts, Orders in Council are still used; and of course in Crown forest reserves the prospector and miner, in common with others, must observe the Forest Reserve Regulations. The comprehensive scope of the Act and its definiteness of detail make it lengthy, but give greater certainty and security to the miner's rights. Allowing prospecting and mining in forest reserves and on lands under timber license and lands of which the surface rights are owned by settlers, which can only be done under provisions necessary to protect the valuable timber and other interests, may cause complication, but it widens the field of the miner's operations.

In the groups of provisions above outlined (omitting No. 5, with which it is not the purpose of the present paper to deal), it will be observed that the first group covers matters which are essentially questions between the applicant and the Crown; the second, matters between individuals, in which the Crown is interested only as it is interested in the general welfare of the mining industry or of the community; while

the third and fourth affect individuals as between themselves as well as individuals in their relation to the Crown. Bearing in mind this dual aspect of the Act will be of assistance in following and applying its provisions.

Each group will be dealt with under appropriate headings.

Requirements for Acquisition of Mining Claims

(a) License.—A miner's license is required for prospecting and for taking up mining claims or acquiring or holding any right or interest therein before patent. It may be obtained at the Bureau of Mines or, except for a company, from any Mining Recorder, and is good throughout the Province. It is not transferable, and it must be renewed on or before 31st March each year. The fee for an individual license is $5 a year; partnership and company licenses are higher and vary according to the number of partners and the capitalization of the company.

(b) Minors.—Any one over 18 years of age may obtain a license and has all the rights and is subject to the same obligations and liabilities as to mining claims and transactions relating thereto as if he were of full age.

(c) Agency.—The requirements for taking up and holding mining claims may be performed by an agent, but for making discovery and staking and recording the agent as well as his principal must have a license.

(d) Lands Open.—All Crown lands and all minerals reserved to the Crown (called mining rights) are open to be prospected and staked out as mining claims if not already taken up, unless expressly excepted, and the exceptions are very limited. Among the lands which are not open at all, or are open only by consent or leave, are lands withdrawn by Order in Council, lands vested in the T. & N. O. Railway Commission, townsites, roads, orchards, gardens, cemeteries, reservoirs, water powers, etc. (secs. 36-43). In Crown forest reserves prospecting must not be done without a forest reserve permit as well as a miner's license, nor work or mining operations without leave of the Minister. Lands under timber license are freely open for prospecting and staking, but work or mining operations must not be carried on upon them without permission of the Minister. Where the mining rights only are in the Crown, the prospector or miner must compensate the owner of the surface rights for any injury done. Particulars as to what lands are open can be had at the recording office, where a map showing all recorded claims is required to be kept for public inspection. Lands already under staking are not open to be prospected or staked out unless the prior staking has lapsed or been abandoned, cancelled or forfeited; but insufficient staking or failure to record within the prescribed time works an abandonment and leaves the lands open, though invalidity of a claim by reason of insufficient discovery does not.

(e) Discovery.—Discovery of valuable mineral is required before a mining claim can be validly staked out. What is to be deemed valuable mineral is defined by the Act. It may be briefly stated as something making it probable that a mine likely to be workable at a profit can be developed from the vein or deposit which is found. A prospector, however, who has found indications may protect his operations on an area 150 by 50 feet by planting prospecting pickets as provided in the Act, and so long as he is diligently and continuously pursuing his search no one else is entitled to make a discovery thereon. There is also the more formal but now little-used procedure of obtaining what is (not very appropriately) called a working permit for cases where discovery cannot readily be made on the surface or without extensive operations. For this, land of the area of a mining claim may be staked out with three rings of notches on the posts, and after 60 days, if no mining claim is staked out thereon within that time, the exclusive right of prospecting and of staking out a mining claim upon it may be obtained for six months, renewable for a further six months, on condition of performing operations to the extent of not less than five days' work each week, or the equivalent in less time, commencing not later than two weeks after the granting of the permit.

Staking out Claims

(f) Claims—size, form, number, etc.—Claims in unsurveyed territory must as nearly as reasonably possible be squares of 40 acres with boundaries running north

and south and east and west, and in surveyed townships must be the aliquot part of a lot or section specified in the Act, but in special mining divisions the area is reduced one half. Not more than three claims can be taken up by a licensee in the same mining division in a license year, but there is no limit to the number that may be acquired by purchase and transfer. The boundaries go down vertically on all sides, and all minerals within them are included in the claim.

(g) Staking.—Staking must be done promptly after discovery, otherwise the discoverer risks the loss of his rights by another discoverer intervening and completing staking before him. The method of staking is very clearly set forth in the Act (sec 54). Posts (of the size and character long used in British Columbia) must be placed at the discovery and at each corner of the claim, and the boundary lines must be plainly blazed and cut out, or, if there are no trees, marked by pickets or mounds, and a line must be marked from the discovery post to the northeast corner, and the posts must be marked with the staker's name and other particulars as specified in the Act. Requiring the planting of posts at the corners and the marking of the boundaries is the plan in use in Ontario since the earliest enactments. Trifling defects will not, but failure to comply substantially with the requirements of the Act as nearly as the circumstances reasonably permit will, invalidate a staking. Unauthorized staking or staking wthout recording disqualifies the staker from again staking out the same land or any part of it unless relieved against (sec. 57).

(h) Recording.—An outline sketch or plan of the claim must be made showing its form and measurements and the situation of the discovery post, and an application and affidavit in the form provided in the Act giving particulars of the boundaries and location of the claim and proving discovery and the date of staking, and showing that the lands appeared at the time to be open for staking, must be made out and sworn, and filed with the Recorder within 15 days after the staking, or where the claim is more than 10 miles in a straight line from the recording office within 15 days, and one additional day for each additional 10 miles or fraction thereof. The fee for recording is $10. If because of there being a claim already on record, or for any other reason, the Recorder refuses to record the application, the applicant may nevertheless have it put on file, where it will remain pending determination of the questions in dispute, but such a filing does not operate as a dispute of the recorded claim and cannot be dealt with as such unless the applicant files a dispute verified by affidavit as provided in the Act.

The Working Conditions

(i) Working Conditions.—Thirty days' work of 8 hours each, consisting of stripping, opening up mines, sinking shafts or other actual mining operations, must be performed on the claim within three months after recording, 60 days during each of the next two years and 90 days during the third year, and a report duly verified by affidavit giving particulars as specified in the Act, must be filed with the Recorder not later than 10 days after the expiration of each period; but the work may be done and the report filed at any earlier time if desired. The holder of two or three contiguous claims may by first filing notice do the work on one or on two for all. Where the land is under timber license, the time does not begin to run until the Minister has directed that the work may proceed; in Crown forest reserves the time begins to run at once, but any time elapsing between application to the Minister for permission to work and the granting of such permission is excluded from the computation; and in all cases any time specifically excepted by Order in Council or time during which mining operations are prohibited by the Minister is excluded. Failure to perform the work or failure to file proof within the time specified forfeits the claim and leaves the land open to other prospectors; but in cases of death, illness, pending proceedings or other unavoidable cause, or of hardship, and where the default is merely in making the report, limited powers of relief are provided for by secs. 80, 85, 86 and 88.

(j) Survey.—A survey of a claim by an Ontario Land Surveyor is required in all unsurveyed territory, and if the Minister deems it necessary he may direct it in other cases.

(k) Patent.—As soon as the other requirements have been complied with application may be made for a patent of the claim (or if it is in a Crown forest reserve, for a lease), and the application must be made not later than three and a half years after recording, the price to be paid for the patent being $3 an acre in surveyed and $2.50 in unsurveyed territory. The patent is granted in fee simple for surface rights as well as minerals, except where the mining rights only are in the Crown, in which case only half the above price is charged, and the miner must compensate the surface owner for any injury or damage, but pine timber is in all cases reserved, and in the northern parts of the province there is also a reservation of 5 per cent. of the area for roads. In Crown forest reserves renewable 10-year leases are granted instead of patents.

Dealings Between Individuals

(a) Transfer. The holder of an unpatented claim may at any time transfer it or any share or interest in it to another licensee, and the latter may work it and complete the requirements and obtain patent.

(b) Agreements for Interests.—To establish ownership or interest in a claim recorded in the name of another licensee, either writing or material corroboration must be had and is sufficient for agreements made before the staking out of the claim; writing (as under the Statute of Frauds) is necessary for agreements made after the staking out.

(c) Recording Transfers and Agreements.—All transfers and agreements affecting a claim may, if executed by the recorded holder or by his attorney appointed by recorded instrument, be recorded upon the claim in the recording office if the signature is verified by an affidavit of execution made by a subscribing witness. Recording is necessary to ensure preservation of priority.

(d) Title.—What may be designated as a record of title to unpatented mining claims is thus kept at the recording office, and a purchaser desiring information should seek it there and may rely upon what he finds much in the same way as he would upon a search at a Registry office. After patent the title goes to the Registry or Land Titles office, as the case may be.

(e) Delinquent Co-holders.—Where an unpatented claim is held by two or more licensees and one of them fails to perform his share of the working conditions, an order may be obtained from the Commissioner vesting his interest in the other holders; and where the interest of a joint holder has ceased by lapse of his license the Minister may direct that it shall vest in the other holders.

(f) Transmission on Death.—On the decease of the holder the Commissioner may within a year direct that the claim shall be vested in the representatives entitled, notwithstanding any lapse or forfeiture that might otherwise have occurred.

Disputability and Indisputability of Claims

(a) Disputes against Claims.—Any licensee, whether he sets up an adverse right or not, may dispute the validity of a mining claim at any time before a certificate of record is granted, provided he specifies the grounds of invalidity and verifies them by affidavit in the form prescribed by the Act and pays a fee of $10; but by amendment of 1910 leave is necessary after the validity of the claim has once been adjudicated upon or after it has been on record 60 days and has already had a dispute entered against it. This amendment was designed to prevent the harassing of the holder by successive disputes which might prevent the issue of a certificate of record.

(b) Certificate of Record.—After a claim has been on record for 60 days the holder may, if there is no dispute standing against the claim, and nothing making it improper to issue it, obtain from the Recorder what is called a certficate of record, which is final and conclusive evidence of the performance of all the requirements of the Act except working conditions up to the date of the certificate, but may, on application of the Crown or of anyone interested, be set aside by the Commissioner for fraud or mistake.

(c) Certificate of Performance of Work.—This may be obtained if the Recorder is satisfied that the work has been duly performed, and is as to conclusiveness and as to setting it aside on the same footing as a certificate of record.

Adjudication of Disputes

(a) Forum.—Generally, all questions and disputes arising before patent as to the validity or subsistence of an unpatented mining claim, or as to its transfer or ownership or as to any other right or privilege or interest conferred by the Act, are decided by the Commissioner or Recorder, subject to appeal as hereinafter mentioned. In practice matters of difficulty or involving much taking of evidence are usually dealt with by the Commissioner, a transfer being made by the Recorder when necessary.

(b) Appeal from Recorder.—An appeal lies to the Commissioner from every decision and every act or thing done or refused or neglected to be done by the Recorder, but unless appeal is lodged within the time provided by the Act the Recorder's decision is final and binding.

(c) Hearings.—The procedure is simple and speedy. Matters are brought to a hearing by obtaining and serving an appointment with notice of the nature and grounds of the claim or dispute, service of the appointment alone being sufficient where the party to be served has already received a copy of the dispute or appeal. Hearings must ordinarily be in the local district. Proceedings are not invalidated by defects where justice has been done.

(d) Decisions.—All decisions must be entered in writing, and the parties affected must be notified of them by registered letter mailed not later than the day after entry.

(e) Appeal from Commissioner.—With a few exceptions specified in the Act, an appeal lies to an appellate division of the High Court from every decision of the Commissioner, but unless taken within the prescribed time the Commissioner's decision is final and conclusive.

Concluding Remarks

Most of the main features of the Act are in accordance with the resolutions of the Miners' Convention held in Toronto in December, 1905. Perhaps the greatest difficulty in satisfactorily working out the present law comes from the attempt to incorporate in it the various recommendations, often in their nature incompatible, made by the different miners' meetings, and in particular from rétaining on the one hand the requirement of discovery, as desired by those who favor that principle, while relinquishing on the other, at the request of those who in practice if not in theory oppose it, the two most effective means of enforcing it, namely, inspection and allowing re-staking of claims without hindrance or delay where the existing staking is not based upon valid discovery. Some other things also, no doubt, could be made better, but in considering alterations the balance must always be struck between the benefit to be derived from them, and the injury inevitably resulting from the unsettling and uncertainty consequent upon frequent change; and the present Ontario Act upon the whole has much to commend it. Its provisions are liberal and calculated to secure fairness and honesty of administration; prospectors and miners are given very wide privileges; mining lands can be quickly acquired, and the expense, apart from development, is slight; rights are clearly defined and title is secure when the law has been complied with; disputes and litigation can be speedily disposed of; the provisions with which the prospector and miner ordinarily have to do are plainly stated; the Act, if long, is very complete; there are no supplementary regulations, and resort to other sources for the law or for information is reduced to a minimum.

THE LAURENTIAN SYSTEM

By WILLET G. MILLER and CYRIL W. KNIGHT

In the early years of the Canadian Geological Survey the pre-Cambrian rocks of Canada were divided into two great groups. The older of these, to which the name Laurentian was given, consists of (1) a great expanse of characteristically banded gneiss or gneissoid granite, called by the early writers Ottawa gneiss,[1] together with (2) sedimentary material consisting essentially of crystalline limestone and gneiss, to which the name Grenville was applied, and (3) a series of rocks of basic composition which was known as the Norian or Upper Laurentian.

The younger group, the Huronian, as then defined, consisted of fragmental rocks of various kinds, but essentially conglomerates and quartzites, derived from the Laurentian by erosion. Certain greenstones in the area first studied on the north shore of Lake Huron were also included in the Huronian. Later work showed that these greenstones should not be placed in this group, and that they are the oldest rocks of the pre-Cambrian. The name Keewatin was applied to them.[2]

When the Keewatin was separated from the Huronian and placed at the bottom of the geological column, the place the Laurentian had formerly occupied, owing to this series being considered the basement series or the oldest of the pre-Cambrian, it became necessary to reclassify or rearrange the table for the pre-Huronian. The classification adopted was:

Pre-Huronian

LAURENTIAN, GNEISS AND GRANITE.

(Igneous contact.)

KEEWATIN.

The name Laurentian was adopted by the Committee[2] for the banded gneisses, or granite gneisses and granites that are intrusive into the Keewatin but presumably not into the Huronian. No distinction as regards age was made between the gneisses and granites. The name Keewatin was applied to the most ancient series of the pre-Cambrian, which consists of greenstones, green schists and other more or less highly metamorphosed rocks, essentially of volcanic type, together with certain sedimentary material represented chiefly by the so-called iron formation, or interbanded silicious material and iron ore, known as jaspylite.

When this classification was adopted the old name Ottawa gneiss was discarded. Moreover, little consideration was given to the Grenville series of southeastern Ontario, as it was felt at the time that the relation of this series neither to the Huronian nor to the Keewatin or Laurentian was understood.[3]

Thus in the course of time the name Laurentian has come to be used in a much more restricted sense than formerly. Instead of embracing both the Ottawa gneiss or granite, the Grenville series and the Norian, it is employed for gneiss and granite that are of pre-Huronian age, or presumably so.

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[1] This gneiss was also known as Fundamental or Trembling Mountain gneiss.

[2] Report of the Special (International) Committee on the Lake Superior Region. Journal of Geology, February-March, 1905. Reprinted in Bur. Mines, Ont., Vol. XIV., and in Sum. Report, Geol. Sur., Canada, 1904, XVIII.

[3] See the Grenville-Hastings Unconformity, pages 221-3, Vol. XVI., Ont. Bur. Mines.

The present authors, however, have felt that the age relationships of the Keewatin, banded gneiss or gneissoid granite, and granites, were not properly understood. Their work, especially in the Cobalt area in the district of Nipissing, had made them acquainted with the fact that there was massive granite older than the conglomerates and other fragmental rocks of the Huronian series in which so many of the cobalt-silver veins are found, as this Cobalt series rests on the eroded, frequently decayed surface of the granite, as well as on that of the Keewatin. While, however, numerous unconformities were known between these rocks, the Cobalt series had not been seen in contact with the typical banded gneiss. Neither had the banded gneiss, which occurs in great volume in the district of Nipissing, been observed in contact with the Keewatin. The age relation between the Keewatin and the banded gneiss, and between the latter and the oldest massive granite, it was thought might be one of two or three kinds, *e.g.*, (1) the banded gneiss might be pre-Keewatin in age; (2) the Keewatin might be older than the banded gneiss; (3) if the Keewatin were older than the banded gneiss, the oldest massive granite might be (4) intrusive into the gneiss, or (5) it might be of the same age as the gneiss. In the last case the difference in character between the granite and banded gneiss might be due to difference in degree of erosion. Since fragmental Huronian rocks were found in contact with the granite and not with the gneiss, it was thought that there might have been more erosion on the gneiss resulting in the removal of the Huronian and the granite facies.

Granite and Banded Gneiss

During the month of May, 1911, we examined the rocks between North Bay and Temagami along the line of the Temiskaming and Northern Ontario railway. From North Bay to Doherty, eight miles south of Temagami, no distinctly clastic rocks were seen. In the vicinity of Doherty, however, a fragmental series similar to that which is of so great economic importance at Cobalt is exposed. The series rests on the eroded surface of a granite somewhat coarse in grain and gray in color. On the railway not far south of Doherty the fragmental series is seen in contact with the gray granite close to the banded gneiss; while to the north it is in contact with the granite and with a basic igneous member of the Keewatin.

The gray granite is cut by two series of acid rocks, both of which are usually finer in grain than the granite itself.

While we do not feel that we have definitely determined the relation of the gray granite to the banded gneiss, still our observations to the south of Doherty led us to believe that this granite graded into the banded gneiss which is also cut by acid intrusions similar to those in the granite. The gneiss appears to be a composite rock, the dark bands representing for the most part portions of the Keewatin included in the intrusive gray granite. Pressure has drawn out the inclusions and produced the banded structure.

Where the granite is in immediate contact with large outcrops of Keewatin, it contains blocks of the latter of considerable size. Proceeding away from the contact the inclusions become smaller in size, and finally the typically banded gneiss appears.[4]

It has been assumed by the International Committee of 1904 and by practically all workers in the Canadian pre-Cambrian in recent years, that the banded gneiss is pre-Huronian in age. In so far as the present writers know, there is little evidence to support this assumption. While undoubtedly certain conglomeratic and other rocks, classed as Huronian, are younger than certain granites, classed as Laurentian, the older Huronian fragmental rocks have not been found in contact with the gneiss. The conglomerate at Doherty, that of the ore-bearing series at Cobalt, that in the county of

[4] There is a good geological map of the area in the vicinity of Temagami and Doherty, by Drs. Barlow and Young, published by the Geological Survey of Canada. Map No. 944.

[Wel]lington in southeastern Ontario discovered by us a year ago, and that of the Shoal lake area in the Rainy River district, are all younger than certain granites on which they rest or in the vicinity of which their outcrops are found. But there is reason to believe that in all the areas just mentioned, there may be conglomerates that are older than the granites. At Sudbury, for instance, the only granites known cut conglomerates and other Huronian rocks.[5] Moreover, it has been believed that in the vicinity of Cobalt there is a series of fragmental rocks older than the typical conglomerates and slate-like greywackés. In the first edition of the report on Cobalt the senior author said: "The pre-Cambrian has been separated into the following series by the writer. It is possible, however, that unconformities exist which have not been located as yet." (p. 33.) In the marginal notes of the first edition of the Cobalt map it is said: "The terms Lower and Middle Huronian are here used provisionally. The formations have not been correlated with those to which the names are applied in the vicinity of the north shore of Lake Huron and elsewhere." A few boulders of what appeared to be conglomerate were found in the conglomerate of the Cobalt series, thus raising the suspicion that there is an older fragmental series in the region. Some of the conglomerates on Lake Temiskaming and some of those on Rabbit lake and elsewhere, judging from the steep dips and disturbed condition generally, probably represent an older series.

It would thus seem that there is little justification for assuming that the banded gneiss of the Laurentian is older than all of the Huronian series. It may be long before the true relationship is determined, since in all the areas mapped the more massive granite facies of the gneiss have been found in contact with the Huronian or with the Keewatin. It would seem from this that the banded facies may represent a deeper seated zone, which is exposed only on the erosion not only of the older fragmental rocks but of the massive granite and Keewatin. Where the two last mentioned series are in contact, the banded structure has not been observed. Probably large masses of Keewatin have tended to prevent the formation of the banded or gneissoid structure in the intrusive, as they would withstand pressure better than a molten or semi-molten magma. In the Lakes Superior-Huron region granites of various ages are known. Even the youngest rocks of the pre-Cambrian are intruded by granite.[6]

Most workers in the pre-Cambrian field will, it is believed, agree with the authors, that much remains to be learned concerning the age relationships especially of the so called Laurentian and the Huronian.

The following notes from the writings of Logan and the two Dawsons are of interest as showing the views held concerning the Laurentian in the past.

Logan's Pre-Cambrian Classification

Logan's early views on the dual subdivisions of the pre-Cambrian, or as he called them, "the Subsilurian Azoic rocks," will be seen from the following:[7]

So early as the year 1845, as will be found by reference to my report on the Ottawa district presented to the Canadian Government the subsequent year, a division was drawn between that portion which consists of gneiss and its subordinate masses, and that portion consisting of gneiss interstratified with important bands of crystalline limestone. I was then disposed to place the lime-bearing series above the uncalcareous, and although no reason has since been found to contradict this arrangement, nothing has been discovered especially to confirm it; and the complications which subsequent experience has shown to exist in the folds of the whole—apparent dips being from frequent overturns of little value—would induce me to suspend any very positive assertion in respect to their relative superposition, until more extended examination has furnished better evidence.

In the same report is mentioned, among Azoic rocks, a formation occurring on Lake Temiskaming, and consisting of silicious slates and slate conglomerates, overlaid by pale seagreen or slightly greenish-white sandstone, with quartzose conglomerates.

[5] A. E. Barlow, Geol. Sur. Can., Pt. II, XIV., and A. P. Coleman, Pt. III., Vol. XIV., Ont. Bur. Mines.

[6] See page 94, Report of Special Committee cited above.

[7] Am. Ass. Ad. Sci., 1857. *The Can. Journal*, Vol. II., pp. 439-442. *Can. Naturalist*, 1857, p. 255.

In the report transmitted to the Canadian Government in 1848, on the north shore of Lake Huron, similar rocks are described as constituting the group which is rendered of such economic importance from its association with copper lodes. The group consists of the same silicious slates and slate conglomerates, holding pebbles of syenite instead of gneiss; similar sandstones sometimes showing ripple-marks, some of the sandstones pale seagreen; and similar quartzose conglomerates, in which blood-red jasper pebbles become largely mingled with those of white quartz, and in the great mountain masses predominate over them. But the series is here much intersected and interstratified with greenstone trap, which was not observed on Lake Temiskaming.

The group on Lake Huron we have computed to be about 10,000 feet thick, and, from its volume, its distinct lithological character, its clearly marked date posterior to the gneiss, and its economic importance as a copper-bearing formation, it appears to me to require a distinct appellation, and a separate color on the map. Indeed, the investigation of Canadian geology could not be conveniently carried on without it. We have, in consequence, given to the series the title of Huronian.

A distinctive name being given to this portion of the Azoic rocks renders it necessary to apply one to the remaining portion. The only local one that would be appropriate in Canada is that derived from the Laurentide range of mountains, which are composed of it, from Lake Huron to Labrador. We have therefore designated it as the Laurentian series.

These local names are, of course, only provisional, derived for the purpose of avoiding periphrastic or descriptive titles the use of which had been found inconvenient, and they can be changed when more important developments, proved to be the equivalents of the series, are met with elsewhere.

J. W. Dawson's Classification, 1889

Over thirty years later practically the same classification as that introduced by Logan was employed in Canada. Thus Sir J. W. Dawson subdivided the Laurentian as follows:[8]

LAURENTIAN

3. Upper Laurentian (Norian of Hunt). Labradorite and Anorthosite series of the Ottawa district, etc.
2. Middle Laurentian, or Grenville Series. Gneiss, diorite, limestone, pyroxene rock, etc.; being the upper part of the Lower Laurentian of Logan.
1. Lower Laurentian or Ottawa Series. Orthoclase gneiss of Trembling Mountain (Logan), Ottawa gneiss (Geol. Survey), Lower part of Lower Laurentian (Logan).

G. M. Dawson's Classification, 1897

About ten years later Dr. G. M. Dawson, then Director of the Geological Survey of Canada, gave a somewhat similar definition of the Laurentian[9] in the following words:

We may ask what is now our conception of these Archæan (pre-Cambrian) rocks in Canada, and more particularly in the great Protaxis, as resulting from the most recent investigations of a critical kind. The reply may be given briefly from the latest reports of those still at work on the problems involved as follows: 'The Laurentian comprises (1) The Fundamental Gneiss or Lower Laurentian (also referred to as the Ottawa Gneiss or Trembling Mountain Gneiss in older reports), and (2) the Grenville Series. . . . . The Upper Laurentian, Labradorian, Norian or Anorthosite group, maintained for a number of years on the evidence already mentioned, is found to consist essentially of intrusive rocks, often foliated by pressure, later in age than the Grenville series, but in all probability pre-Paleozoic.'

Reverting to the original classification of the Archæan of the Canadian Survey, as developed in the field by Logan and his assistants, we may now inquire—In how far does this agree with the results of later work above outlined? In the main, this classification still stands substantially unaltered, as the result of all honest work carefully and skillfully executed must. The nomenclature adopted is still applicable, although some of our conceptions in regard to the rocks included under it have necessarily undergone more or less change.

[8] Handbook of Canadian Geology, 1889, pp. 57-58.
[9] Presidential address, section C., Brit. Ass. Ad. Sci., 1897, p. 634.

The Laurentian is still appropriately made to include both the Fundamental Gneiss and the Grenville series; although at first both were supposed to represent 'metamorphic' rocks, it was even then admitted (1855) that these embraced some plutonic masses practically inseparable from them. Later investigations have increased the importance of such plutonic constituents, while, at the same time, demonstrating the originally supposed sedimentary origin of the characteristic Grenville series, but the admission of so large a plutonic factor necessarily invalidates in great measure the estimates of thickness based upon the older reasoning, under which any parallelism of structure was accepted as evidence of original bedding.

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Government Road, near Frederick House Lake.

TWENTIETH ANNUAL REPORT

OF THE

BUREAU OF MINES, 1911

VOL. XX., PART II.

THE PORCUPINE GOLD AREA

BY A. G. BURROWS

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1911

VOL. XX **PART II**

THE PORCUPINE GOLD AREA

BY A. G. BURROWS

Situation

The Porcupine gold area, which for the past two years has held the attention of the mining public, is situated on the Hudson Bay slope of northern Ontario. The latitude of Niven's First Base Line of 1899, which runs through the centre, forming the south boundary of Tisdale and Whitney, is 48° 27′ 54″; consequently the area is somewhat farther south than the Canada-United States boundary in Manitoba and other western provinces. The main part of the camp is in the Sudbury judicial district, about six miles from its eastern boundary. Lying along the southern fringe of the great clay belt of northern Ontario, it adjoins a prospective farming country. In this belt many townships have been laid out in six or nine-mile squares and subdivided into mile blocks; in the gold area itself and in the adjoining country to the north, many quarter sections (160 acres) have been granted to veterans as homesteads. Up to the present time prospecting and underground development have shown that Tisdale is by far the most important township, while promising discoveries have been made in other townships in the vicinity, including Whitney, Ogden, Shaw, Deloro and Langmuir. Immediately to the west and north of Tisdale the country is deeply covered with drift.

To the south and southeast of Tisdale a number of townships have been outlined in six-mile blocks during the past year, and these boundary lines furnish good ties for prospectors who are examining the outlying areas.

A geologically colored map, scale one mile to one inch, accompanies this report.

Ingress to the Area

During the past winter a great quantity of supplies, building material, mining machinery, etc., was taken into Porcupine by way of Kelso, which, at the present time, is the nearest railway station. Kelso, by rail, is 449 miles north of Toronto, and Porcupine lake lies 24 miles to the southwest. The winter season affords a favourable time for moving supplies into the country, since roads which are impassable in the summer are excellent in the winter when used for sleighs. The transportation of supplies during the open part of 1910 was exceedingly difficult, owing to the lack of suitable roads from Kelso to Frederick House lake, and from Hill's Landing on the Porcupine river to Porcupine lake. Most of the supplies were taken in by wagon from Kelso to the southwest end of Frederick House lake, and there transferred to gasoline launches and "pointers" and transported by way of Frederick House river, Night Hawk lake and Porcupine river to Porcupine lake, a total distance of 52 miles.

Porcupine river was much improved for navigation by the construction, by private parties, of three locks and a dam. Practically all the low-lying roads have to be filled in with corduroy or stone to make them suitable for hauling supplies.

Porcupine lake, from which the camp derives its name, is the distributing point for the mineral area. Seven townsites have been laid out adjacent to the lake, and many buildings, including hotels, stores, banks, etc., have been erected.

At the present time the Ontario Government is constructing a branch line of the Temiskaming and Northern Ontario railway from a point two miles north of Kelso to the centre of the area, a distance of about 28 miles. The railroad will run down the eastern side of Porcupine lake.

At first rapids above Hill's landing, Porcupine river.

Topography

In elevation the area averages about 1,000 feet above mean sea level. In this respect it is similar to the Cobalt area, which lies 100 miles to the southeast, south of the height of land. The divide between the Hudson Bay and the St. Lawrence waters is not pronounced, being only about 1,300 feet above sea level

The country from Night Hawk lake to the Mattagami river is one of low relief. Occasional ranges of hills reach an elevation of 150 feet, but generally abrupt changes in elevation are less than 50 feet. Often in a low area rocks outcrop only a few feet above the surrounding drift and are only a fraction of an acre in extent. Northwest, southwest and southeast of Porcupine lake the country is somewhat elevated, and rock exposures are more frequent than in most of the area.

Superficial Deposits

The area is for a considerable part drift-covered. These drift deposits consist largely of stratified clays, sands and gravels of post-glacial age; and in addition there are patches of moraine material. Sections of stratified clay, overlain by sand, are well exposed on the Mattagami river, north of Pigeon rapids, and along the shores of Night Hawk lake. Most of the islands in this lake have a rocky shore line, but are capped by stratified material. Where the soil has been removed the rocks are seen to have been intensely glaciated. The fine-grained greenstones have well preserved the scratches and grooves produced by glaciation. On several islands were noted two sets of striations, S. 15° W. mag. and S. mag. the latter of which represents the later ice movement. Owing to the lack of drainage, much of the country, though higher than the rivers and lakes, is very wet, but would be suitable for agricultural purposes if properly drained.

Glaciated surface, Night Hawk lake[2]

Over most of the area there is a dense growth of timber, including black and white spruce, jack pine, poplar, balsam and birch. During last season much of the timber on the higher ridges was burned by forest fires. In this district, however, the forest fires are not wide spread, since there are numerous spruce flats and swamps where fire makes little headway. A growth of young tamarac is replacing the larger tamaracs which have all been killed in recent years by the larch saw-fly. For a description of the agricultural possibilities of the country the reader is referred to reports by Mr. A. Henderson.[1]

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[1] Agricultural Resources of Abitibi, Bur. Min., Vol. XIV. (1905); Agricultural Resources of Mattagami, Bur. Min., Vol. XV. (1906).

[2] Bur. Min., Vol. VI. (1896).

Early Examination of Area

Previous to three years ago the area was little known. There were practically no reports upon it except from explorers and geologists who were attached to survey parties sent out by the Ontario Department of Lands, Forests and Mines.

The main part of the camp is situated along an old portage route, from the Mattagami river to Night Hawk lake, which had been used by the Hudson Bay Company officials for a couple of centuries.

In 1896 Mr. E. M. Burwash examined the country along the Algoma-Nipissing boundary line which was run as far as the southeast corner of Whitney township in that year. He noted the occurrence of quartz veins, carrying traces of gold, at various points on the line. One of these veins he found on what is now the east boundary of Shaw, and only a few miles southeast of the main area. He remarked that the country was a promising one for the prospector but for the drift.[2]

Townsite at northwest corner of Porcupine lake. Nov., 1910.

Following the classification of the pre-Cambrian in use at that time Mr. Burwash grouped the Keewatin with the Huronian. He says:—

"In the lower part of the series [now considered to be mainly Keewatin] gold appears to be quite widely distributed both in veins which are of tolerably frequent occurrence and in mineralized portions of the rock itself. In two cases the veins were situated near the boundary of granite areas."

In 1899 Mr. W. A. Parks reported on the geology of the portage route from the Mattagami river to Night Hawk lake by way of Porcupine lake. He, like Burwash, noted the occurrence of gold in some quartz veins, particularly in the southwest portion

of Whitney township, obtaining assays from a trace to $1.00 per ton. In his summary Mr. Parks remarked: "I regard the region south of the trail to Porcupine lake as giving promise of reward to the prospector."[3]

Geological descriptions of areas, including and adjacent to the Porcupine area, are to be found in the reports of the Bureau of Mines for 1903, 1904 and 1905 by Messrs. Kay, McMillan and Kerr, respectively.

In October, 1909, Mr. Jas. Bartlett made a brief examination, for the Bureau of Mines, of the early discoveries of the area.[4]

Glaciated surface. Night Hawk lake.

Early Prospecting

In 1906 some work was done by prospectors on a vein near Miller lake and a few hundred feet from the present Hollinger vein. Evidently seeing no free gold, and having no assays made, they abandoned the property. In the same year claims were staked in Shaw township on what is described in the application as a vein of sugar quartz and hematite iron. This is of interest since the so-called vein is simply the upturned edges of the Keewatin iron-formation.

In 1908 claims were staked by Mr. A. G. Hunter on the east shore of Porcupine lake in Keewatin formation. Native gold was found sprinkled through quartz and schist in a sheared zone.

[3] Bur. Min., Vol. IX. (1900), Niven's Base Line.

[4] Bur. Min., Vol. XIX. (1910).

It was not, however, until the following year that the spectacular discoveries of J. S. Wilson, on what is now the Dome property, caused a rush to the district, and in a few weeks practically all of Tisdale and a great part of the adjoining townships and unsurveyed territory were staked out in mining claims.

Geology

The compact rocks of the area may all be referred to the pre-Cambrian.

Pleistocene

Post-glacial—stratified clay, sand.
Glacial—boulder clay.

Overlooking Kamiskotia lake, from diabase hill to the southwest. July, 1910.

Pre-Cambrian

Post-Lower Huronian—quartz-diabase, etc.

(Igneous contact.)

Huronian—conglomerate, quartzite (coarse greywacké), slate or delicately banded greywacké.

(Unconformity.)

Laurentian—granite, intrusive into the Keewatin, and in part pre-Huronian.

(Igneous contact.)

Keewatin—The series consists chiefly of basic and acid volcanics, which are now much altered to schists, banded iron formation, rusty weathering carbonates, etc.

The Keewatin and Huronian have been subjected to much greater metamorphism than at Cobalt. From an economic standpoint these formations are the most important, since they contain the gold-bearing veins.

The post-Lower Huronian rocks are largely basic dikes of a diabase or gabbro character, and are of little significance in this area.

Keewatin

The Keewatin has a much greater distribution in the Porcupine area than the other members of the pre-Cambrian, and it is also of more importance economically, since it contains the greater number of the gold-bearing veins which have so far been discovered.

Indians on Night Hawk lake.

As in other parts of Ontario the series is highly metamorphosed, and many rocks are so much altered as to give little evidence of their original character. However, much of the series can be seen to consist of basic and acid volcanics such as basalts and porphyries, although these are often altered to schistose types. Where schistose, the general strike over a considerable area is found to vary from east and west to northeast and southwest, while the dip is generally steep to the north.

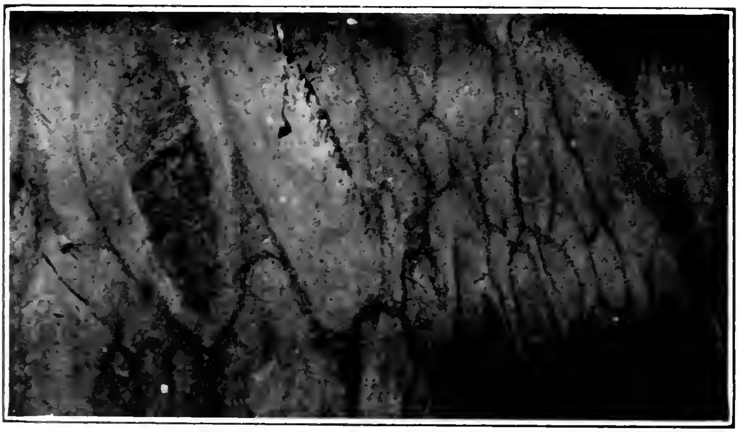
Among the more massive rocks are greenstones (basalts, etc.), which frequently show a striking ellipsoidal or pillow structure. Amygdules often accompany this structure and occur most abundantly along the rims of the ellipses. The centres of the ellipses are often bleached to a light greenish or whitish colour, whereas the margins are considerably darker. This structure is frequently seen in the northwest part of Whitney township. It is very pronounced in the greenstone along the shores of Night Hawk lake and on the islands in this lake. On the main land opposite Callinan's island in

Night Hawk lake, the ellipsoidal greenstone has been rendered quite schistose, so that the structure appears as alternate light and dark bands. Some of the greenstones have been brecciated and resemble conglomerate.

Serpentines occur in parts of the area in large volume. The range of hills immediately southeast of Porcupine lake are largely composed of this rock which is impregnated with much carbonate. Occasional veinlets of fibrous asbestos are seen, but this mineral was not noted in any quantity. A section of a sample of serpentine rock from the southeast shore of Porcupine lake is made up largely of fibrous serpentine, together with residual iron oxides, which in arrangement suggest original crystals like olivine. The remainder of the rock is dolomite. A chemical test showed the absence of chromium oxide in this rock.

In other thin sections are recognized diabasic and basaltic textures indicating that much of the greenstone is derived from rocks of this character.

The rock from the boundary between Whitney and Tisdale, about the middle of the fourth concession, is a fine-grained amphibolite, consisting essentially of hornblende, epidote, zoisite and calcite.



Ellipsoidal greenstone. Night Hawk lake.

The light-colored more massive rocks are principally quartz-porphyries and felsite, which in places intrude the more basic rocks. When the porphyry occurs in some volume, as around the Hollinger mine, the name rhyolite has been applied to it. Much of the porphyry has been altered to a sericitic schist, and frequently a rather massive rock can be traced into a very schistose one. This change can be well seen in the porphyry to the southwest of the Dome mine workings. A porphyry from the south half of lot 4 in the first concession of Tisdale, examined in thin section, shows the phenocrysts to be largely plagioclase feldspar, while quartz in rounded grains is also present. The groundmass is made up principally of plagioclase feldspar and quartz. Laths of tourmaline are scattered through the rock.

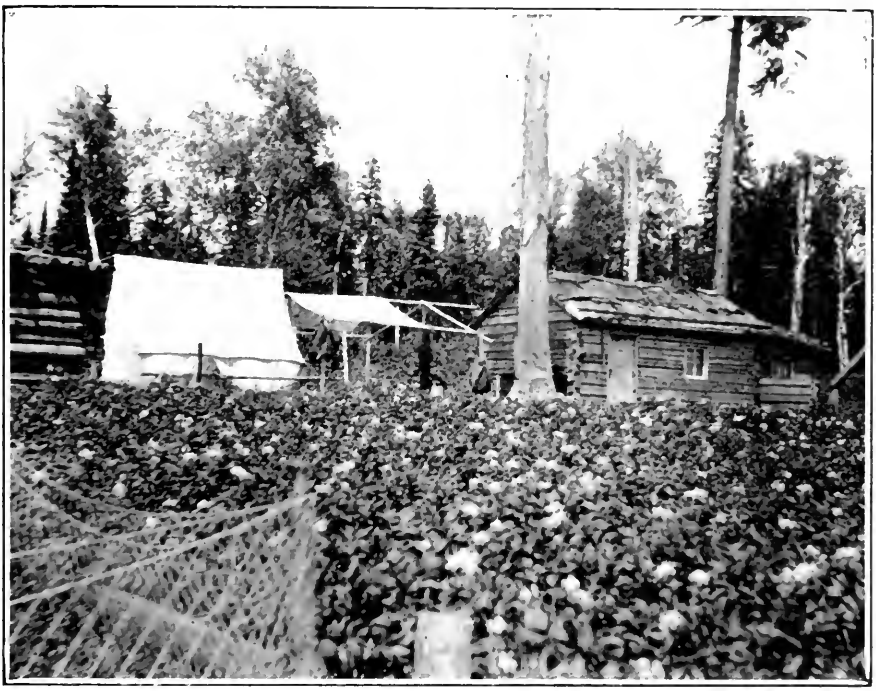
While many of the Keewatin rocks are now highly schistose, and can only be called hornblende, chlorite or sericite schists, occasionally remnants of amygdules, or eyes of quartz, in clear glassy grains, indicate the volcanic origin of some of them.

A spotted rock, from the northeast part of the West Dome in lot 5 in the first concession of Tisdale, is probably an altered amygdaloidal lava. The schistose matrix consists of secondary material, dolomite, sericite, etc., and the amygdules, whose margins are stained with limonite, are filled with calcite, sericite, and quartz. Some of the amygdules are an inch in length.

At times the Keewatin has been much crushed and broken, so that the rock has the appearance of a conglomerate; so much so that in the vicinity of the Dome mine, where graywacké and conglomerate occur, it is impossible to make a close line of distinction between the autoclastic and true conglomerate.

Iron Formation

Banded iron formation, grouped with the Keewatin, has an extensive development in parts of the area. It outcrops frequently in the southwest part of Whitney township in the first and second concessions. The disturbance in the formation here has not been so great as in other parts. Often the bands are lying almost horizontally. In places they have been somewhat brecciated, but otherwise little disturbed. The bands are



Indian camp, with potato patch. Kamiskotia lake. July, 1910.

alternate reddish or grayish sugary quartz and magnetite or hematite. Sometimes the narrow bands of magnetite, one-eighth inch thick, carry a merchantable percentage of iron, but these are relatively subordinate in comparison with the main mass of rock. It is unlikely that merchantable iron ore will be found in quantity. In parts of the formation iron pyrites replaces the magnetite. Almost horizontal, interbanded iron pyrites and silica are seen on the south half of lot 5 in the second concession of Whitney. A sample of banded quartz and iron pyrites gave 40 cents in gold per ton. Iron pyrites occurs in considerable quantity with a sugary quartz on lot 9 in the second concession, and might be worthy of investigation as a source of sulphur.

In Deloro and Shaw townships the iron formation is more highly tilted—generally from 60° to nearly vertical. Bands can be traced for several miles in a direction somewhat south of west. In this position, and especially where the iron ore is deficient, the formation greatly resembles wide quartz veins, and many prospectors have done

considerable stripping and prospecting along it. The formation is frequently cut by quartz veins in which visible gold sometimes occurs. In most cases the prospector has considered the iron formation itself to be a quartz vein or dike, and low gold values have been obtained from some of this material, especially where secondary iron pyrites is present.

Carbonate Rocks

In various parts of the area associated with Keewatin rocks are carbonates to which various terms have been applied, such as: dolomite, ferro-dolomite, ferruginous carbonate and ankerite.[5]

There is much uncertainty as to the origin of this rusty carbonate rock in different parts of the area. The carbonates may occur in at least three different ways, namely, as original bedded material, as a replacement, and as vein filling. Impure carbonates are formed also by the decomposition of basic igneous or other rocks.

Ferruginous carbonate intersected by quartz stringers. Night Hawk lake.

Dr. W. G. Miller, in his notes with the first edition of the Porcupine map, states that certain dolomites of the area may correspond to the crystalline limestone of eastern Ontario. Further he says: "It would appear not unlikely that carbonate in some places is a replacement mineral, and that a considerable volume of rock may at times have been replaced by carbonate."

In the township of Deloro there are bands of carbonate which are closely associated with bands of iron formation which may be traced for several miles in an east-west direction. The relationship would suggest a similar origin for these rocks, that is, as beds deposited in sea water and now resting in an inclined position dipping to the north. These dolomite bands are frequently intersected with quartz veinlets, carrying some gold values, hence their importance. The bands have recrystallized and carry veinlets of later carbonate, as well as quartz.

In the northeast part of Tisdale and the adjoining part of Whitney, there is considerable rock which carries a high percentage of carbonate. This impure carbonate rock is much fissured by quartz veins, as on the Armstrong-McGibbon, lot 1 in the fifth concession of Tisdale, and other properties in the vicinity.

Several samples of rock which effervesce strongly with acid show an original igneous structure under the microscope. A sample from near one of the Davidson veins

[5] The name "ferro-dolomite" is not recognized by Dana and other authorities.

on the southwest quarter of the south half of lot 2 in the fifth concession of Tisdale is a medium-grained, greenish, much altered, igneous rock. Plagioclase feldspar, showing albite twinning, may still be recognized, and also micrographic intergrowths of quartz and feldspar. The remaining minerals are secondary—chlorite, calcite, etc., and make up a large part of the rock which is probably a quartz-diorite or grano-diorite. Another rock, taken from a cross-cut at 90 feet depth, on the Scottish Ontario property, is an altered basalt. The plagioclase feldspar is largely altered to saussurite minerals, while the ferro-magnesian mineral has gone to chlorite, and magnetite to leucoxene. Calcite is present in considerable quantity as a secondary mineral. Other examples

Ferruginous carbonate cut by quartz stringers. Night Hawk lake.

could be cited showing the replacement of igneous rock by carbonate. It is believed that this process has continued in some cases to such an extent that the rock is now largely carbonate, while the original rock constituents are leached out, or so altered as to show little trace of the igneous origin.

Analyses were made of some impure carbonates which occur with the quartz veins in northeast Tisdale.

—	1.	2.	3.
	Per cent.	Per cent.	Per cent.
Insoluble	51.82	58.63	47.35
Calcium carbonate	19.38	19.59	20.98
Magnesium carbonate	6.08	8.06	8.50
Ferrous carbonate	13.19	11.53	12.19

No. 1. is an impure carbonate from near the west end of the main quartz vein on the Davidson claim. N.W. ¼, S. ½, Lot. 2, Con. 5, Tisdale.

No. 2 is from the south wall at the east end of the vein and is quite schistose

No. 3 is from the Crown Chartered property—just northwest of No. 1 shaft.

Similar impure carbonates occur at the Armstrong-McGibbon, Scottish Ontario and other properties near by, and also in other parts of the area—as at the Rea vein, lot 6 in the third concession of Tisdale.

Microscopic examination of the above rocks shows them to be entirely secondary. There is an abundance of sericite and a minor quantity of quartz present in the sections.

That there has been considerable migration of carbonate solutions is shown by the manner in which almost all the rocks of this area are more or less impregnated with it. Sections of quartz-porphyry schist show the presence of much calcite as a secondary mineral. Veins and veinlets of ankerite occur frequently, not only in basic rocks but in the quartz-porphyry. On the Preston claim, immediately south of Simpson lake, there is a 3-foot vein of ankerite in quartz-porphyry. On the east Foster claim there is a similar vein in Keewatin schist.

The origin of some of the ankerite bands, such as are seen in the Curts "vein" on the West Dome properties, is difficult to explain. Analyses of samples of this ankerite show it to be almost free from insoluble impurities, in which respect it is quite different from the carbonate occurring in northeast Tisdale. The distinct walls of the band of carbonate suggest a vein or bed origin for it rather than a replacement. Analyses of carbonte from different parts of the Curts vein are given in columns 1 and 2.

—	1.	2.	3.	4.
	Per cent.	Per cent.	Per cent.	Per cent.
Insoluble	1.73	....	11.42	....
Calcium carbonate	50.63	51.28	46.63	42.76
Magnesium carbonate	29.57	29.82	28.77	19.86
Ferrous carbonate	14.15	14.70	5.39	12.01

No. 3 is an analysis of ankerite from a narrow vein on the east Foster claim (West Dome).

No. 4 is an analysis of a very dark gray ankerite from a vein on the Gray claim, Ogden township.

Similar Rocks in Other Areas

Carbonate rocks are characteristic of all the gold-bearing areas of northern Ontario.

Larder lake, which lies about 70 miles east-southeast of Porcupine, is referred to by Mr. R. W. Brock as follows:

> The most interesting rock from an economic standpoint near Larder lake is a rusty weathering dolomite (?). About 60 per cent. of the rock consists of lime-magnesia, iron carbonate, the remainder of quartz and a soft green talcose silicate, probably serpentine. The origin of the rock is as yet a little uncertain. Certain dikes, when squeezed and altered, produce a rock which bears a strong resemblance to it, but its occurrence with slates and phyllites and with the cherts—undoubted sedimentary rocks—as a conformable band . . . . render it more probable that it is an altered stratified ferriferous dolomite, probably forming a member of the iron ore formation. This rock, especially where cut by the porphyry or pegmatite . . . . is traversed by innumerable stringers of quartz which in places are gold-bearing.[6]

Mr. Morley Wilson also refers to Larder lake, and to Opasatika lake to the east, as follows:

> In the neighbourhood of Larder lake and north of lake Opasatika are local outcrops and bands of a rusty-weathering rock consisting of ferruginous dolomite or ankerite, with varying quantities of quartz and feldspar. It is always highly pyritic and in most localities contains a large amount of chrome mica or fuschite from which the rock derives its color. As a rule the rock is cut in a most complex manner by two or more sets of veinlets of quartz or of quartz and ferruginous dolomite, the dolomite occurring along the margin of the veinlet and the quartz in the centre.[7]

[6] Bur. Min., Vol. XVI. (1907), p. 207.

[7] Summary Rep. Geo. Sur. Can., 1909.

M. B. Baker describes a similar carbonate rock in his report on the Abitibi lake area,[8] and also A. A. Cole in his report on the gold-bearing deposit at Gold Island in Night Hawk lake.[9]

Some of the gold deposits on Temagami lake are associated with carbonate. W. G. Miller refers to these in his report on "The Iron Ores of Nipissing District":

At Ferguson point a pit has been sunk in quartz and dolomite. The appearance of these two minerals in association is interesting as the mixture of the two resembles closely the gangue of some of the auriferous mispickel ore bodies in Hastings county. There are some other masses of more or less silicious dolomite along this (northeast) arm of Temagami, in Emerald lake and elsewhere.[10]

A. L. Parsons describes a carbonate as occurring at the Regina mine, Lake of the Woods:

No. 3 vein is principally quartz, though in places a good percentage of a rusty carbonate is found intermingled with the quartz. The west vein which is about 20 feet wide, consists of two parts, that upon the north being quartz interbanded with rusty carbonate, while the southern portion consists entirely of this rusty carbonate.[11]

In the same area at West Shoal lake, A. P. Coleman describes the veins at the Oliver Daunais location as quartz mixed with a good deal of dolomite. In some cases the latter mineral contains a few specks of free gold.[12]

Carbonate rocks are also associated with iron ore deposits in northern Ontario, as at Helen mine, Michipicoten. In this locality there are masses of siderite impregnated with iron pyrites, from which, according to A. P. Coleman, the hematite ore has been derived.[13]

It will be seen that the carbonate rocks of the pre-Cambrian have a wide distribution in northern Ontario. They vary considerably in composition, but are represented for the most part by crystalline limestone in which $CaCo_3$ predominates. Other carbonates are ankerite, siderite and dolomite. In one locality the crystalline carbonate has the composition of magnesite.

A strikingly green colour is often seen in the ferruginous carbonate rocks of the area. It is well shown in these rocks on Night Hawk lake. N. L. Turner, Provincial Assayer, obtained decided reactions for chromium in a sample from Night Hawk lake, suggesting the presence of a chromium silicate. Mr. Morley Wilson describes a similar green mineral from Opasatika lake as a chrome mica or "fuschite."

A similar mineral has been reported to occur on lake Abitibi and elsewhere.[14]

A chrome-magnesia mica (biotite) occurs in the township of Hyman, Algoma district.[15]

Fragmental Rocks

There has been included with the Keewatin some material which appears to be of sedimentary origin. For example, some of the schistose rock which outcrops at Wawaitin Falls and at points below, on the Mattagami river, has a graywacké structure when examined in thin section. On Red Sucker creek at the third rock exposure from the Mattagami river, there is a fresh-looking graywacké which greatly resembles some

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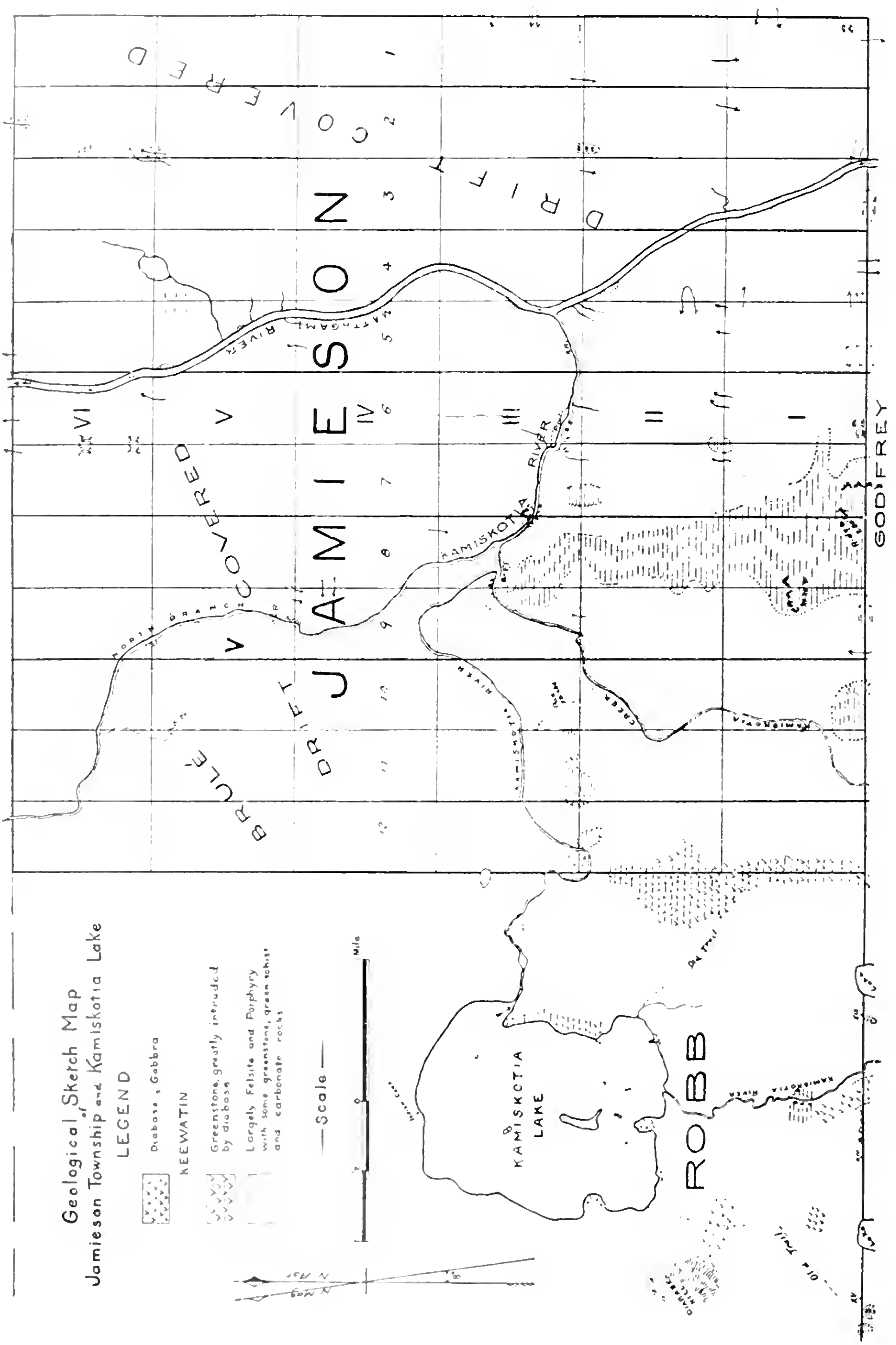
[8] Bur. Min., Vol. XVIII. (1909), p. 270.
[9] Ibid., Vol. XVI. (1907), p. 220.
[10] Ibid., Vol. X. (1901).
[11] Ibid., Vol. XX. (1911).
[12] Ibid., Vol. VI. (1896), p. 105.
[13] Ibid., Vol. X. (1901), p. 193.
[14] Ibid., Vol. XVI. (1907), p. 219.
[15] Report Geol. Sur. Can., Vol. VI. (1892-3), p. 27 R.


Geological Sketch Map of Jamieson Township and Kamiskotia Lake
LEGEND
Diabase, Gabbro
KEEWATIN
Greenstone, greatly intruded by diabase
Largely Felsite and Porphyry with some greenstone, green schist and carbonate rocks
Scale
Mile
JAMIESON
DRIFT COVERED
VV COVERED
BRULÉ DRIFT
GODFREY
ROBB
KAMISKOTIA LAKE
MATTAGAMI RIVER
KAMISKOTIA RIVER
NORTH BRANCH RIVER
CREEK
VI
V
IV
III
II
I

of the Huronian graywacké at Cobalt. The rock consists largely of fragments of quartz and feldspar with some bits of rock like quartz-porphyry in a cement of finer material consisting of quartz, feldspar, sericite, etc.

At the lower end of the third sandy portage on the Mattagami river below Timmins' landing, the rock is now schistose, but is made up of bands of coarse and fine material which tail out like sedimentary deposits. This rock, however, may be composed of volcanic fragmental material which has been water-sorted.

At the middle and upper sandy portages, the rock has a fragmental appearance in the field, but Mr. C. W. Knight, from an examination of thin sections, suggests that such rocks may have been originally quartz-porphyry, which is now much crushed and impregnated with carbonate. One sample contains somewhat rounded grains of quartz and feldspar in a fine interlocking matrix of quartz and feldspar, with sericite and calcite.

On the south boundary of Jamieson in lot 7, about 4 miles northwest of Sandy Falls, there is a volcanic rock, now somewhat schistose, but the porphyritic character of which is distinct, with phenocrysts of clear quartz in a dense dark gray felsitic groundmass. The rock described at Sandy Falls may be similar to this, but more highly altered.

Post-Huronian Dikes

In all parts of the area are numerous basic dikes which are generally less than 100 feet in width. Some of these are of olivine diabase. One such dike occurs on the south boundary of Whitney township in lot 12. The rock shows fairly fresh plagioclase set in ophitic fashion in augite. The latter mineral has a decided purplish colour, due to the presence of titanium. Grains of olivine showing high relief, a few scattered flakes of biotite and magnetite, also occur.

Basic dikes intruding Keewatin greenstone occur on several islands in Night Hawk lake. A thin section of one of these shows a diabasic texture. Rods of labradorite are set in augite, which is beginning to alter to green hornblende. Quartz is present in clear grains and as an intergrowth with albite.

A similar diabase intrudes the Huronian graywacké on the northeast bay of the lake. Many of these narrow basic dikes in this section greatly resemble the sill diabase of the Cobalt silver area.

A dike of diabase 10 feet wide cuts a ferruginous carbonate rock on the most southerly Dome claim in Tisdale. At this point the carbonate is not intersected by quartz veinlets, and it was not possible to determine the relationship of the dike to the quartz veins.

There is a very prominent hill about 250 feet high to the southwest of Kamiskotia lake which is composed of a basic rock, some of which is very coarse grained like gabbro. This mass is likely a great dike, with northeast-southwest strike, which crosses Niven's line two miles to the south-west.

Thin sections of two samples of the rock have the structure of gabbro, rather than diabase. Quartz, if present at all, is only in minor quantity, and the rock does not closely resemble the Cobalt sill diabase.

Huronian

Huronian rocks occur in various parts of the area, and are of importance, since on several properties they carry gold-bearing veins. The largest area of Huronian stretches from the Dome mine in a northeast direction for about ten miles. Unlike similar rocks at Cobalt, Gowganda and Larder lake, the series is highly inclined, and has been subjected to considerable metamorphism. The general strike of the upturned edges of the series varies from east and west to northeast and southwest, and conforms generally to the prevailing strike of the Keewatin rocks. Much of the deformation of the area was therefore in post-Huronian times. In some outcrops are recognized a succession of conglomerate, quartzose-graywacké, and delicately banded graywacké,

indicating well-sorted sedimentary material. This ternary succession of strata is characteristic of the Huronian at Cobalt and surrounding areas. Variously colored layers are often seen in the graywacké, and a secondary cleavage is frequently developed. The alteration of the Huronian even in this limited area has been varied. At times the strata show only as inclined beds, and again, as at the Foley-O'Brian, they have been so much crumpled that they show wavy bands along the strike. A thin section of graywacké from a mile west of the north end of Porcupine lake shows angular fragments of quartz and feldspar, together with sericite and other secondary minerals.

At the Dome property, in contact with the large quartz masses, is a conglomerate which is likely basal. On the weathered surface the included fragments of porphyry, greenstone, schist, etc. ,are conspicuous, but in freshly broken pieces the conglomeratic character is easily overlooked, since the rock breaks in prismatic blocks resembling schist. The included pebbles are frequently drawn out in the direction of the schistosity.

Huronian graywacké, with strike east and west and dip 85° north, occurs on the northeast shore of Night Hawk lake. In the graywacké are thin bands of conglomerate containing pebbles of dark green Keewatin rock, numerous quartz pebbles and some felsite. Some of the pebbles are 6 inches in diameter. A sample of the graywacké is seen under the microscope to consist of angular fragments of quartz and feldspar, with finer particles of the same material and chlorite, sericite and limonite.

Laurentian

A few outcrops of granite occur in the township of Whitney. This granite is a medium-grained biotite variety, and not typical of that occurring in large volume to the north and south of the area. In south Whitney it intrudes light-colored porphyry of Keewatin age, but its relation to the Huronian is not known.

About 40 miles north of the gold area there are frequent outcrops of granite and gneiss. The known outcrops of rock to the south are mainly of Keewatin age. Granite occurs on the Mattagami river just north of Loon portage, and the contact runs to the eastward, crossing the Frederick House river south of Neelands rapids, and thence southeasterly to near Iroquois Falls on the Abitibi. To the north of these points for some miles the rock exposures are largely granite or gneiss.

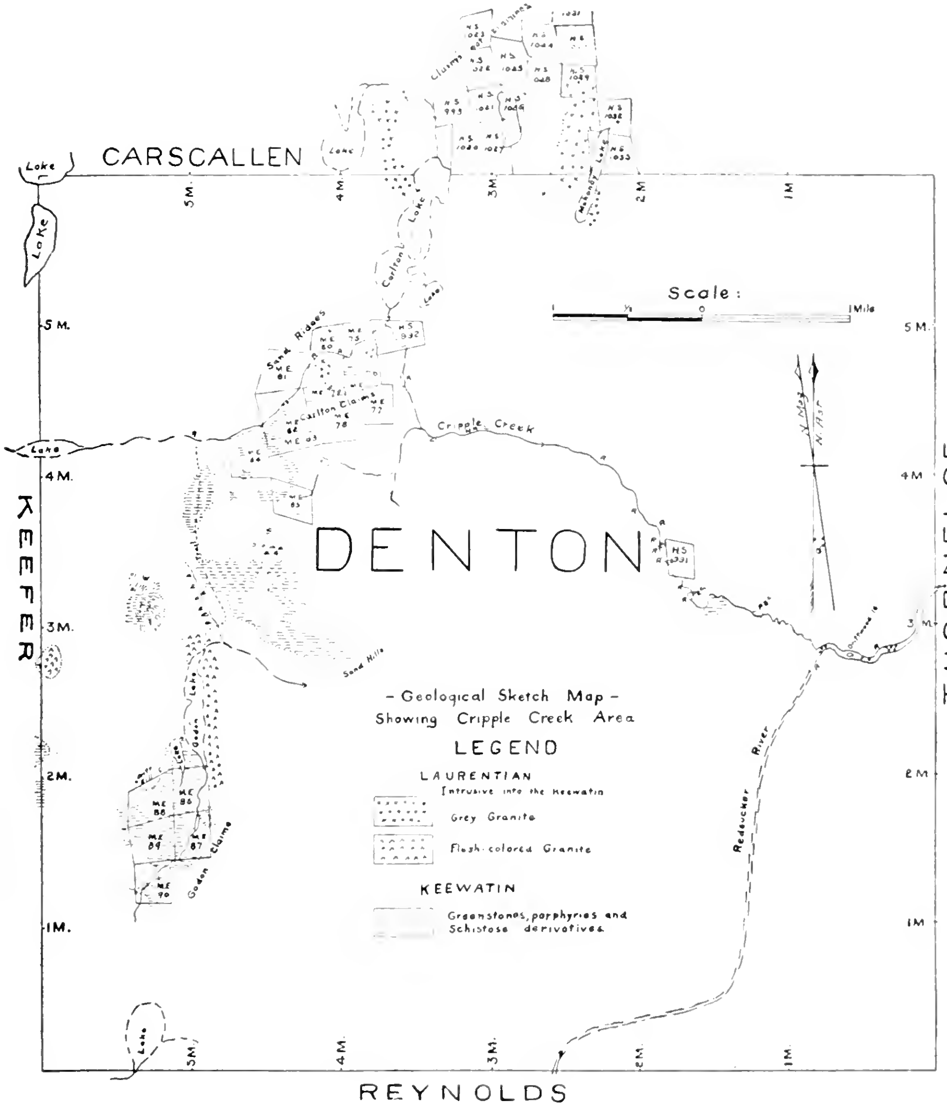
Again, granite occurs on the Mattagami river south of Wawaitin portage, which is southwest of Porcupine. There are also outcrops of this rock along the south boundaries of Price and Adams in association with basic Keewatin rocks, which they intrude partly as narrow dikes. The granites are largely of a flesh-colored hornblende, biotite variety. The only gneissoid structure observed is a paralleling of the constituent minerals. Some of the granite is porphyritic with phenocrysts of pink feldspar up to two inches in length. A reddish variety from the east boundary of Fripp township is a hornblende granite, showing in thin section quartz, albite, hornblende, apatite and titanite. The hornblende is partly altered to chlorite.

In the notes accompanying the first edition of the Porcupine map, it has been suggested that the formation of the bold-bearing veins is due to the intrusion of granite into the Keewatin and Huronian formations, and that the immense quantity of quartz present in the veins has been drawn from the residual silicious waters of this rock. During the past season no granite was seen directly in contact with Huronian rocks, so that the relation of the granite to the Huronian is not clearly known.

At one place on the south boundary of Langmuir township is a small patch of Huronian conglomerate which contains some pebbles of granite, so that at least some of the granite in the vicinity is pre-Huronian. No granite pebbles were found in the conglomerate in Whitney and Tisdale townships. It may be that the granite mass which threw off the silicious waters is at some depth, and does not show any surface outcrop in the vicinity of the gold deposits.

In the township of Denton, about 30 miles southwest of Porcupine, a gray biotite-granite intrudes Keewatin greenish and grayish schists. Gold-bearing veins have been found in both the Keewatin and in this gray granite rock, so there may be some relation-

ship between these quartz veins and the gray granite. A reddish hornblende granite occurs in the same township, but its relation to the biotite granite is not apparent. Where granites intrude the Keewatin, but are not found in contact with the Huronian, it is practically impossible to say whether their age is Laurentian or post-Lower Huronian.



Relation of Quartz Veins to Granite

Mr. C. W. Knight noted the occurrence of feldspar in a vein on the Miller-Middleton, one of the Timmins locations, and suggested the relationship of the deposit to granite or pegmatite dikes. It has been noted, too, in the main Hollinger and other veins. Feldspar is also seen in the quartz veinlets which intersect the carbonate rocks on Night Hawk lake. In the same locality are aplite dikes with fine veinlets of quartz from which low gold values have been obtained. It is possible that the quartz veins, quartz-feldspar veins and aplite dikes are but differentiations from the same magma.

The relationship of quartz veins to pegmatite and aplite has been mentioned by several writers. In the Black Hills of South Dakota, C. R. Van Hise noted the gradual transition from intrusive granites through pegmatite dikes and with decreasing quantity of feldspar to quartz veins remote from the granite.[16]

J. E. Spurr in "The Geology of the Yukon Gold District, Alaska," referring to a set of younger quartz veins on Forty Mile creek, says: "They often contain a little feldspar and sometimes, by increase in amount of this mineral, pass into a variety of fine pegmatite. This in turn seems to be transitional into a coarse aplite which is very abundant."[17]

De Launay in his work, "The World's Gold," refers to the relation of gold to the granitic rocks. "At Berezovsk in the Urals in certain veins of microgranite, which themselves cut talcose schists, there are numerous very thin veins of auriferous quartz, containing various sulphides of copper, lead and bismuth, with gold, chromium, and tourmaline, and the granitic mass from which the micrograniles are derived appears itself to be auriferous."

In support of the theory of the relation of the quartz veins of Porcupine to granite intrusions, may be mentioned the following:

1. The irregular occurrence of the quartz in many of the deposits, in lenticular masses, resembling pegmatite dikes.

2. The occurrence of feldspar and tourmaline in the quartz in several deposits.

3. The great pressure at which the quartz has been deposited, indicated by the presence of liquid inclusions and gas bubbles. These are frequently seen in quartz in granites.

4. The frozen contacts of quartz and enclosing country rock. The free walls seen at some properties indicate a secondary movement in the quartz since these walls are slickensided. Where free walls exist they may be either the hanging or foot wall, while the other wall is indistinct—grading into the country rock.

5. The occurrence of narrow aplitic dikes, frequently cut by minute veinlets of quartz which represent the final solidification of the aplite magma and frequently carry gold values as on Night Hawk lake.

Character of the Gold-Bearing Deposits

The occurrence of gold at Porcupine is associated with the quartz solutions which circulated through the fissures in the Keewatin and Huronian series. The irregular fissuring has produced a great variety of quartz structures, varying from the tabular, though often irregular or lenticular, vein which may be traced several hundred feet, to mere veinlets, often only a fraction of an inch in width and a few feet in length, which ramify through a rock that has been subjected to small irregular fissuring. This latter variety is well illustrated in the fissuring of ankerite bands, so characteristic of many of the gold deposits of Porcupine. Irregular and lenticular bodies of quartz often occur which may have a width of ten or twenty feet, but which die away in a distance of fifty feet. Again there are dome-like masses of quartz which are elliptical or oval in surface outline, but whose underground extension has not been examined closely.

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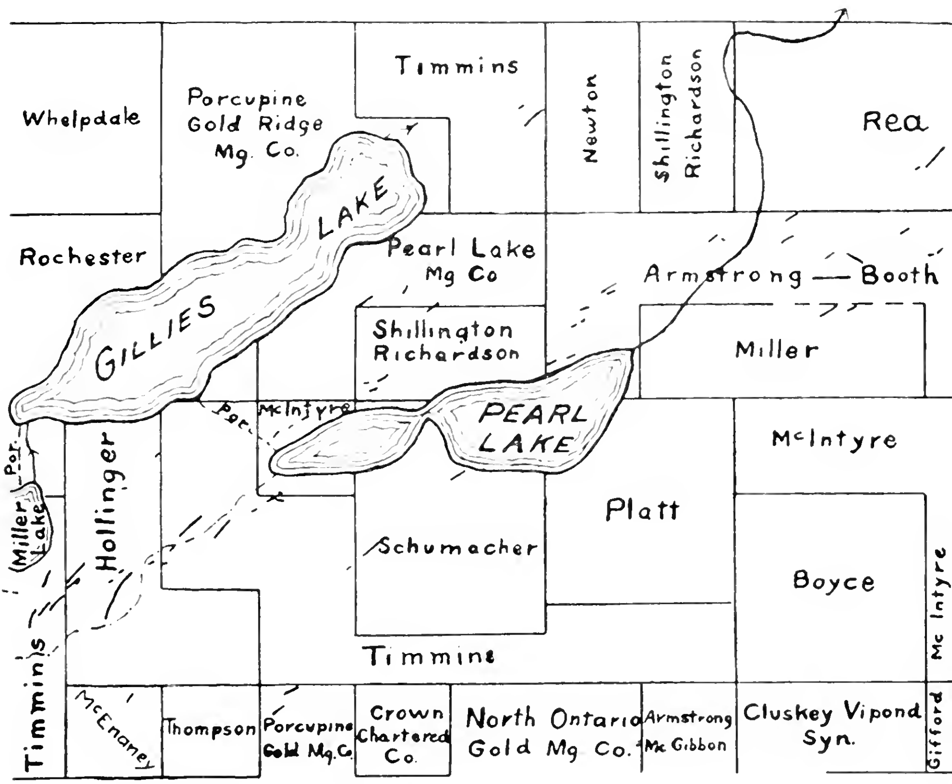
[16] U. S. Geological Survey, 16th Annual Report, Principles of North American Pre-Cambrian Geology.

[17] U. S. Geological Survey, 1896.

In some parts at least these masses can be seen in contact with underlying rocks at a low angle, which would suggest that they are broad lenticular masses which have filled lateral fissures in the country rock. The most conspicuous dome masses are those of the Dome property where the two largest are about 125 feet by 100 feet. A fissure may be vertical and regular at some points. At others it may incline at a lower angle to the horizontal or take on a more or less lenticular form.

The relationship of the strike of the veins to that of the enclosing rock is often difficult to determine, since generally along the veins there has been shearing of the country rock which may conform to the general direction of the strike of the veins. However, by determining numerous strikes in the schist away from the veins, it is seen that the majority of them are inclined to the direction of strike of the enclosing



Distribution and strike of veins near Pearl Lake.

rocks. In dip the veins vary from vertical to nearly horizontal. In No. 1 shaft of the Hollinger the vein is practically vertical, while a series of narrow quartz veins, 6 to 18 inches wide on the Lindburg claim, have a dip at the surface of only 20°. The prevailing dip of the schist in the Porcupine area is to the north at a high angle, and frequently the veins dip distinctly to the south across the cleavage of the schist. While it is apparent that most of the deformation of the country antedates the vein formation, nevertheless there is a decided tendency in many cases for the fissuring to be influenced by the direction of schistosity, which is also a direction of weakness; hence we find veins having a more or less lenticular structure the strike of which closely corresponds to that of the country rock.

Distribution of Veins

While gold-bearing veins occur over a wide area and are often isolated, it is seen, from a number of those already discovered, that they occur in groups along certain lines. For instance, in Tisdale township there are at least three distinct areas where the fissuring has been most pronounced. One such area extends from the southeast end of Miller lake, on lot 11 in the first concession, in a northeasterly direction for three miles, and includes such veins as the Miller-Middleton, Hollinger, McIntyre and Connell or Rea, and in addition many others with visible gold. The average strike of the veins here is northeast-southwest. Another series, including the Davidson, Crown-Chartered, Armstrong-McGibbon, and Bannerman (in Whitney), occurs in the northeast part of the township in the fifth concession. The general direction of the veins is east and west. Again in the southeast part of the township is a group including the Foster, Dome and Dome Extension, with general strike somewhat south of west. Similar groupings could be mentioned in other parts of the area.

In these disturbed zones the country rock is generally schistose in character. At the Dome mine the disturbed area has a width of about 600 feet, in which there are numerous narrow quartz veins in addition to large irregular quartz masses.

Well defined, disturbed zones occur in the fifth concession of Tisdale. In this locality the main rock is a light greenish, fine-grained, rather massive greenstone. This greenish rock is itself not much fissured, but here and there through it are bands of rusty-weathering carbonate, which is generally schistose, striking east and west. I think that much of the carbonate associated with this greenstone is of secondary origin. It is possible that the shattering and fissuring of the greenstone in an east and west direction may have caused a deposition of migrating carbonate solutions, partly filling fissures and partly replacing the greenstone. These carbonate bands were later fissured, and gold-bearing quartz solutions deposited in them. The fissuring of the carbonate is generally irregular, and hence we find veins with steep or low dip striking with the schist and across it. This irregular series of veins is seen at the Crown-Chartered and Armstrong-McGibbon properties. Where the veins are small, it becomes necessary to mine both the carbonate and the intersecting quartz veins. Gold often occurs in the carbonate near the contact with the quartz veins, as well as in the quartz.

Distribution of the Gold

While the quartz is considered to carry the gold, it was noted at many properties that the metal occurs in greatest quantity along certain lines which give a streaky character to the ore. On the surface these streaks are rusty due to the oxidation of pyrites, while at depth they are dark gray or greenish in colour.

Thin sections of quartz from the main Hollinger vein show grains of quartz with irregular outline, which often contain liquid and gas inclusions. There has also been much secondary pressure, indicated by strain shadows or wavy extinction, and along lines of slip or fracture planes there has been much crushing of the quartz to finer grains. In these crushed areas are secondary minerals like calcite, sericite, etc., while iron pyrites is also present in cubical form and has evidently crystallized, subsequent to the crushing.

Some thin sections from the Rea mine main vein also show much secondary crushing along lines. Calcite and sericite are present in the crushed quartz generally in linear arrangement, and in addition there are several rough crystal outlines of free gold which were formed subsequent to the crushing.

These fine dark streaks may have resulted from a solidification and shrinkage of the quartz forming filmy cracks, which may have become slip or crushing planes along which the richer gold-bearing solutions were deposited at a later period.

These minute dark streaks in the quartz are frequently slickensided, and this character may often be seen in hand specimens, as from the Rea or Vipond mines.

It should be noted that where cracks or fracture planes have been produced in a quartz vein and subsequently filled by minerals from solution, secondary quartz can be

West outcropping of Armstrong-McGibbon ore body.

Narrow quartz veins in Keewatin carbonate schist at Dome property. Nov. 1910.

distinguished with difficulty, if at all, from the original quartz. Hence it is not always possible to say whether visible gold in such a vein occurs in the original or in secondary quartz.

Carbonates of lime, magnesia and iron occur with the quartz in practically all the veins in the area. This material may have been absorbed from the wall rock, which is frequently dolomite or rock impregnated with dolomite or calcite. Fragments of country rock are often included in the veins. Veinlets of clear calcite occasionally cut the quartz veins.

The distribution of the gold is generally irregular, occuring along one or both walls, while other portions of the vein may be very low grade. Most spectacular showings occur on many properties, but these are limited to portions of the veins. Considering the irregular character of certain veins and the quantity of country rock which will need to be mined, the ore must be considered low grade.

Iron pyrites occurs in massive and crystallized forms, somewhat sparingly in most of the veins. Cubes of pyrites are frequently abundant in the enclosing rocks, especially where sericitic or dolomitic schist occur. A sample of cube pyrites was separated from the schist, obtained from a shaft of a principal property, and an assay gave a gold content of $10.40 per ton.

Copper pyrites, galena, zincblende and pyrrhotite are found in some veins in very minor quantity. Sulphide of silver, argentite, occurs in association with the gold on the Powell property in Deloro township.

It will be seen from an examination of the ore from most of the properties that it is largely free milling, while the concentrates should be amenable to cyanide treatment.

Little is said in this report as to actual values of properties, since their sampling is the prerogative of their owners. Many samples were taken for assay, rather for the determination of the distribution of the gold, which was found to be irregular and to be associated with the secondary fracturing of the quartz (and schist) in many cases. The determination of the value of properties is a matter requiring considerable development accompanied by extended sampling and mill tests.

In the following is a brief description of a few of the working properties. Gold has been discovered on many claims, some of which discoveries are of recent date. A part of the coming summer will be devoted to an examination of these properties.

The Dome Mine

This property, comprising six claims, is situated in the first concession of Tisdale, and includes parts of lots four and five. The main workings are on the northwest forty acres of lot four. In an area, which is roughly 600 feet wide north and south and 800 feet long east and west, there are frequent occurrences of quartz in irregular masses and narrow quartz veins, in some of which there is visible gold. Toward the east end of the workings there are large dome-like masses of quartz in contact with Huronian conglomerate and slate-like greywacké, while to the west the quartz occurs chiefly as narrow veinlets associated with Keewatin schist which is impregnated with carbonate. The country rock in the proximity of the veins contains considerable crystallized iron pyrites. The general distribution of the quartz masses and veins is shown on the detailed map of the Dome accompanying this report.

The surface of this deposit was sampled during the summer of 1910, while a part of it was tested by underground workings, consisting of five shafts, one raise, and about 1,000 feet of drifting and cross-cutting at the 40-foot level. In addition, seven diamond drill holes averaging 400 feet tested the property at various points. During the latter part of the summer a 1,500-lb Nissen stamp was used for sampling purposes. As the result of this prospecting the company decided to equip the property with a modern 40-stamp mill and cyanide plant, to treat the mass as a low grade ore body, mining both schist and quartz.

Quartz masses in connection with schistose conglomerate. Dome mine. Nov., 1910.

Quartz mass at the Dome mine.

A main 8′ x 18′ shaft will be sunk to the north of the present No. 2 prospecting shaft. Both the mine and the mill will be operated by electric power, for which purpose about 1,000 horse power will be required. Ten air drills will be used for breaking down the ore.

The mill treatment of the ore will be as follows:—

Preliminary crushing will be done in two stages, using No. 7½ and No. 5 Kennedy gyratory crushers. Belt conveyors will carry the ore to the stamp feed bins. Chalmers and Williams' 1,250-pound gravity stamps will be used with straight-back rapid-discharge type mortars, screen 18-mesh or coarser. The foundations will be reinforced concrete. Outside amalgamation will be adopted. Superimposed Dorr drag classifiers will be installed over tube mills of the El Oro type, which will be followed by a second set of amalgamating plates. Hydraulic cone classifiers will discharge back to tube mills and overflow to Dorr thickeners. Agitation will be accomplished in a series of continuous Pachucas. Combined thickeners and press tanks will feed to Merril slime presses, which will discharge through automatic tailing samplers.

The gold will be precipitated by the Merrill zinc-dust process. The zinc-dust will be fed by a short conveyor belt, operated by means of floats and counter-weights, at a rate proportional to the volume of solution pumped from the tank. The zinc-dust will be discharged into a mixing cone and the emulsion agitated by a jet of air. A small stream of barren solution will provide a constant overflow which will carry the emulsion down a pipe to the suction of the pump. The solution will be pumped to triangular precipitating presses, precipitation taking place entirely during the passage of the solution through the pump, pump-column and presses. The precipitates will be acid-treated, fluxed and smelted.[18]

West Dome Mines

This property, commonly known as the Foster, is directly southwest of the Dome in lots five and six. There are several veins on this property, some of which occur near the Dome boundary. These are narrow, averaging possibly two feet in width, and consist of ankerite and quartz. One shaft has been sunk to a depth of 25 feet on a vein which dips about 75° to the north. The greatest attention, however, has been paid to the deposit known as the "Curts vein," which is situated in the southwest part of the property. This vein has been stripped at various points, over a distance of 1,200 feet, showing a width of about three feet up to twenty-two feet. The deposit has well-defined schist walls, and dips steeply to the north. In proximity to the vein the country rock is rusty weathering, but away from the vein is a greenish Keewatin schist. The main mass of the lode is a lime-magnesia-iron carbonate, the composition of which is given earlier in the report. This mass is variously called ankerite or ferruginous carbonate. In fresh material the carbonate has a gray to light bluish colour, but on the surface is much stained to a rusty brown, which has resulted partially from the oxidation of iron pyrites but chiefly from ferrous carbonate. In parts of this carbonate rock there has been fracturing and filling with quartz and a later carbonate The quartz veinlets vary from mere threads up to two feet in width, the widest of which are mostly transverse to the strike of the lode and end abruptly at the schist walls. Unequal weathering of carbonate and quartz has resulted in a striking ribbed structure. Native gold occurs in patches in the quartz and also in the carbonate near the quartz, indicating an enrichment of the carbonate from the quartz veins. When the property was visited on February 21st the development consisted of only two shafts, which were down 32 feet and 45 feet respectively, so that little was known at that time as to the actual value of the deposit.

[18] Canadian Mining Journal, Vol. XXXII., No. 4, p. 126

Ankerite intersected by quartz veinlets, West Dome. Oct., 1910. View looking south across the lode.

Looking west along the ankerite lode on the West Dome property.

The Hollinger Mines

The property consists of four claims lying to the east of Miller lake in the southwest part of Tisdale. There are a number of quartz veins which have a general northeast and southwest strike. The distribution of these is shown on the detail plan of the Timmins properties accompanying the Porcupine map. Development has been largely confined to the southeasterly vein of the series, which is generally known as the main Hollinger vein. This vein has the characteristic lenticular structure, which is frequently seen in this area, widening in places to 15 feet and again narrowing to a few feet. Two vertical shafts, No. 1 and No. 3, 625 feet apart, have been sunk 100 feet. Of these No. 1 is a 14 x 6½ ft. 3-compartment shaft, and has been used as the main working shaft. No. 2 shaft, which is midway between the others, was discontinued at 60 feet.

No. 1 shaft at Hollinger mine. March, 1910.

No. 1 and No. 3 have been connected at the 100-foot level by a drift along the vein. On February 19th this drift had been extended 300 feet northeast of No. 1 shaft, and at a point 120 feet from No. 1 shaft a 6 x 9 ft winze had been sunk 114 feet. The vein as exposed at the surface, at the bottom of No. 1 shaft and at the bottom of the winze is nearly vertical. A cross-cut had also been run from a point 110 feet south of No. 1 shaft 100 feet to the southwest towards the second vein of the series.

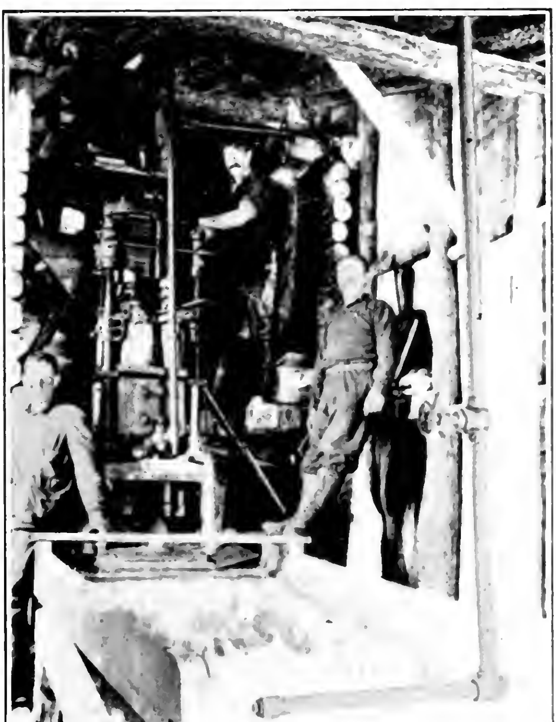
The gold in the ore occurs chiefly along dark seams in the quartz in which there is iron pyrites. These seams are well distributed in much of the quartz in this vein. Copper pyrites, zincblende and galena occur in minor quantity. Other minerals in the vein are calcite, dolomite, sericite and chlorite. Fragments of wall rock are frequently included in the vein. The wall rock is a grey sericitic schist impregnated with carbonate and iron pyrites.

For the past year a 2-stamp Tremaine mill has been treating about 4 tons of ore per day, which represented only a small portion of the ore raised from the mine during development.

Much of the wall rock, which is impregnated with iron pyrites, is said to carry gold values for some distance from the veins. This can be treated with better results by cyaniding.

A mill will be erected during the coming year.

No. 1 shaft at Hollinger mine, showing ore dump. Oct., 1910.



Two stamp Tremaine mill, Hollinger mine.

The Rea Mine

The Rea property consists of two adjoining 160 acre veteran claims in the north half of lots 6 and 7 in the third concession of Tisdale. Several veins, with visible gold, have been discovered on the property, but most of them, beyond stripping, have not been developed. Attention has been chiefly confined to the vein known as the Connell, which is on the lot line between the claims. This vein strikes north 47° east magnetic, and has been traced, partly by trenching in the low ground to the northeast, a distance of 300 feet. When seen in February this vein was being tested by two shafts 150 feet apart. The more northerly No. 1. or "Kingsmill" shaft had been sunk vertically to 85 feet, while at 75 feet cross-cuts had just been started. The vein where exposed at a depth of 30 feet has a dip of 85° northwest. The hanging wall, which is well defined, is much slickensided and grooved vertically. The quartz has been subjected to much movement, showing frequent slickensides along dark seams, which occur for the greater part in the direction of the vein and show over a width of about two feet. Numerous stringers of quartz, from a few inches to two feet in width, extend from the main vein into the foot wall. The greatest enrichment occurs along the north wall, where gold is frequently seen along the dark seams in association with iron and copper pyrites. A little native copper was found near the surface in No. 2 shaft. This shaft, the "Eakins," was being sunk on the inclination of the vein and had reached a depth of 25 feet.

Preston East Dome Mines

On the Preston claim, H. R. 826, in Deloro township adjoining Tisdale, the rock associated with the gold veins is a quartz-porphyry, which in part has been fractured and filled with narrow quartz veins, some of which will average from 5 inches to 15 inches in width. These narrow veins cut across the general strike of the formation in a north and south direction. In places the porphyry has been sheared and fractured, showing dark seams along which gold sometimes occurs. When seen in November, 1910, the property had not been developed beyond some stripping and a few shallow pits. During the winter a compressor plant and 2 Nissen stamps were taken in to test the property.

Armstrong-McGibbon

On the Armstrong-McGibbon claim, the northwest quarter of the south half of lot 1 in the fifth concession of Tisdale, there is a band of impure carbonate rock with an east and west strike, which towards the west is exposed for a width of 50 feet. This rock has been considerably fractured in an irregular manner, and quartz veins occur at many points. These veins, towards the west part of the band, have a dip to the south at about 35°, whereas the schistose carbonate rock dips to the north. Gold has been found in very coarse and spectacular form at several places in the quartz, and the best values are obtained along the line of quartz and schist, especially where slips occur. On the west part of this band of fractured rock a 7 x 9 ft. shaft had been sunk 65 feet, encountering narrow veins of quarts dipping to the south, in all totalling about six feet. Six hundred feet to the east a second shaft had been sunk 30 feet. Here the quartz veins have a decided dip to the north.

The property was equipped with a 30-h.p. boiler and a 6 x 8 ft. hoist, and drilling was being done by hand.

Scottish Ontario

On the Scottish Ontario property in northwest Whitney there are several veins exposed on the surface with approximately east and west strike.

An 8½ x 5 ft. shaft had been sunk 100 feet and at 90 feet cross-cuts had been started north and south. The north cut had been extended 80 feet, while at 50 feet it

cut a mass of quartz on which drifting had just begun. The rock in the cross-cut is Keewatin greenstone, a soft decomposed basalt at the breast and a hard quartz diorite at 30 feet from the shaft. This hard rock was also exposed in the shaft at 40 feet. The cross-cut was to be continued northward to cut two well-defined veins which were exposed on the surface for over 400 feet.

A 24-h.p. boiler is used to run the hoist, and drilling is done by hand.

Powell Claims

The claims of the Powell group are in the northeast part of Deloro township. A band of rusty weathering carbonate with much serpentine occurs on M. E. 22, M. E. 21 and adjoining claims. This band has a strike somewhat south of west, varies in width from 35 feet up to 75 feet and dips to the north at about 60°. In parts of this band there are veinlets of quartz and dolomite in which visible gold has been found. The veinlets of quartz have a general strike of northeast and southwest. In one part argentite occurs in association with the gold.

Two 50-foot shafts one-half mile apart have been sunk in the hanging wall of the carbonate band at points where the rock is much intersected by quartz veins.

Vipond

This property is the principal claim of the Porcupine Gold Mines Company.

There are several narrow quartz-ankerite veins having a general northeast and southwest strike. When visited in February last the main development had been confined to No. 3 vein, which had been traced for several hundred feet on the surface. A 4½ x 9 ft. 2-compartment shaft had been sunk to the south of the vein a depth of 100 feet, and a cross-cut of 42 feet made to the vein. Drifting had been started in both directions along the vein which at this depth showed a width of 18 inches to 2 feet, dipping to the southeast at about 83°. The vein consists largely of quartz, but in addition there is considerable carbonate, some in the form of clear calcite.

On No. 3 vein a shaft had been sunk 50 feet, but at 23 feet the vein dipped out of the shaft and no cross-cut to it had been made.

One Nissen stamp was in operation and a small amount of bullion had been produced.

Foley-O'Brian

This property is situated half a mile west of the south end of Porcupine lake, where, on a ridge of Huronian rock which outcrops through the drift, the main workings are located to the north of the main road.

No. 1 shaft has been sunk 70 feet. The surface was not exposed, but it was stated that this shaft had been sunk on a quartz outcropping. As seen underground, the quartz appears to occur as a lens, but more development is necessary before the character of the ore body can be determined.

At the 37-foot level the quartz mass is about 26 x 35 feet in horizontal dimensions, while it shows in the shaft for 20 feet deeper, and from a lower cross-cutting appeared to be dipping to the east.

A second shaft had been started to the south of No. 1 shaft on high ground, since the first shaft was located close to a creek and much water was encountered.

A 4-drill compressor plant had been installed and 3 drills were in operation.

Messrs. E. L. Bruce, P. E. Hopkins, W. L. Uglow, A. W. Gray and R. C. Easton acted as assistants during the season of 1910.

Mr. C. W. Knight spent a short time in the field making a detailed map of the area in the vicinity of the Hollinger.

The topographical part of the survey was in charge of Mr. W. R. Rogers.

The assays and analyses mentioned in the report were made by Mr. N. L. Turner, Provincial Assayer, Belleville.

WATER POWERS IN THE PORCUPINE AREA

The value of water powers has increased greatly in recent years owing to the introduction of electricity and long distance transmission of electrical energy. To-day practically all water power developments may be classed as hydro-electric. Hence it is easy to see the great possibilities afforded by Ontario's hinterland, which abounds in water powers.

Some idea of our resources in this particular may be obtained by referring to the Reports of the Hydro-Electric Commission. In addition Mr. L. V. Rorke, Inspector of Surveys, has contributed a valuable paper on "Water Powers on our northern slope to James Bay, Province of Ontario."[1] In this part of the Province alone he estimates the total available horse-power at two million. If Ontario lacks coal the disadvantage is offset by the great opportunities afforded in the ultimate development of her "white coal" resources. The application of hydro-electric power to mine operation in Ontario was the subject of an article by E. T. Corkill, Inspector of Mines, in the last report of the Bureau of Mines.[2]

A copy of the Regulations stating the conditions under which water powers are leased may be had on application to the Department of Lands, Forests and Mines, Toronto.

It is the intention in this article to refer only to those water powers within easy radius of the Porcupine gold area. The importance of such water powers in close proximity to a mining camp does not call for further comment.

Grassy Falls

On the Grassy river at the boundary line between the townships of Price and Fripp there is a series of falls and rapids, somewhat in the shape of a horseshoe, with a total descent of 106 feet. A flume and pipe line cutting across the horseshoe would be one-half mile in length. At low water stages, without storage, the river will have a flow of about 100 cubic feet per second. This is equivalent to 1,000 horse power.

Waiwatin Falls

This falls is situated on the Mattagami river in the northeast part of the township of Thorneloe. Like the water power on the Grassy river, this is a series of falls and rapids and of similar shape. For development purposes a flume and pipe line about 70 chains long will be required. The total fall under natural head is 116 feet, and the flow 400 cubic feet per second, at low stages, giving about 4,000 horse power. The drainage area at this point on the river is approximately 1,200 square miles.

Surveys and plans for this development have been completed, although no machinery is on the ground. The transmission line has been located on sand plains and jack pine ridges for almost the entire distance, with the object of constructing either a wagon road or electric railway. The dam required can be easily constructed. E. A. Wallberg has leased this water power and under the conditions must develop 4,000 horsepower of electrical energy by September, 1912. The transmission line to the Hollinger mine is eleven and one-half miles in length.

Sandy Falls

Sandy Falls is located on the Mattagami river in concessions IV. and V., Mountjoy. This water power consists of a series of three falls with intervening rapids and swift water. The upper part has been leased to the Porcupine Power Company, while the lower part is under lease to other parties. Under natural conditions the total descent is 44 feet.

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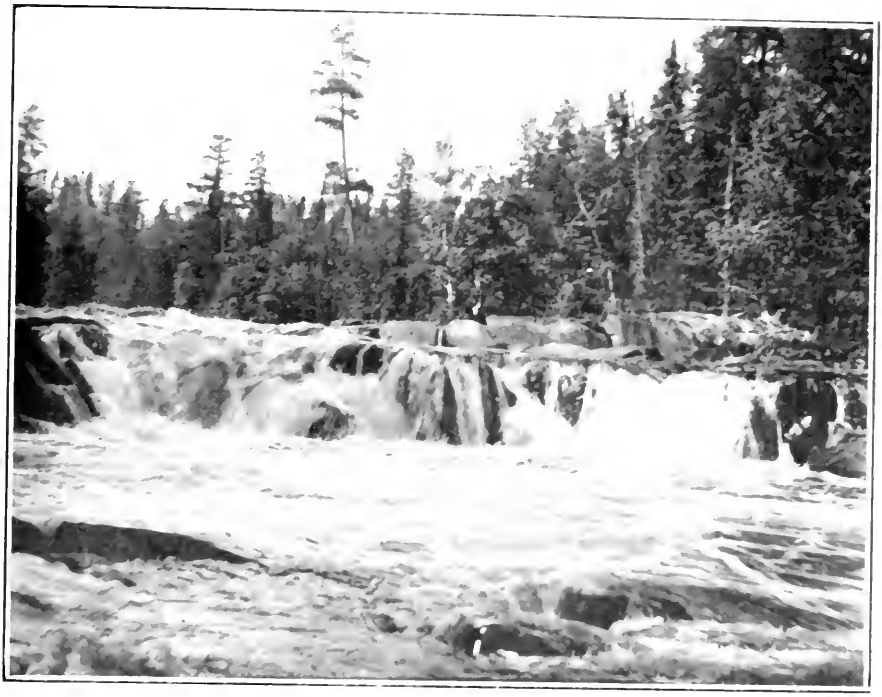
[1] Annual Report of Ontario Land Surveyors, 1910.

[2] "Water Powers for Working Mines,' Bur. Min., Vol. XIX. (1910), Part I.

Active development work by the Porcupine Power Company has been carried on during the past winter, and the company expects to supply electrical energy by early summer. Two electrical units of 1,500 horse power each are being installed. The transmission line from the power house to the Hollinger mine is six miles in length. The right-of-way, 132 feet in width, has been cleared of timber and a pole line erected.

At Sandy falls the natural head has been increased by a dam which will eliminate all current from the river as far upstream as Timmins Landing, or the mouth of Mountjoy creek. This will allow the power plant to operate under an effective head of 34



Part of Waiwatin falls on Mattagami river.

feet. Although the available head here is much less than at Wawaitin the volume of water is greater. The drainage area of the Mattagami river at Sandy falls has been increased to about 2,500 square miles by the additional territory supplying tributary feeders, namely, Mountjoy creek and the Grassy and Redsucker rivers. Thus, without storage, a flow variously estimated from 800 to 1,400 cubic feet per second will be obtained at low water stages. Lakes near the head waters of the Mattagami can be dammed, thereby retaining flood waters to increase the flow at low stage periods. Experience has shown that many of the rivers of northern Ontario have an average flood discharge of about twenty times the low water flow.

THE ALEXO NICKEL DEPOSIT

By W. L. UGLOW

Location

The Alexo mine, as the ore-deposit has been called, is situated on lot 1 in the third concession of Dundonald township, very close to the boundary of Clergue; "Mileage 222," on the Temiskaming and Northern Ontario Railway, is 4½ miles to the northeast of the mine, and an old winter road from Kelso Mines to Porcupine passes a few yards from the workings.

Topography

The general appearance and relief of the country do not suggest the presence of ore-bodies. It is part of the "clay belt" and partakes of its well known characteristics. Frederick House lake lies in a shallow depression some three miles to the west of the mine. The land for a distance of a mile and a half to two miles from the lake is a rolling clay loam, thickly timbered with spruce, balsam, poplar, birch, etc. This area is succeeded by a sand plain reaching down from the north, which has been recently burnt over. To the south and east of the sand plain are found the only rock exposures of the township, with the exception of a fringe bordering the promontory on the east shore of the lake, and an island immediately to the south of this. Concessions 1, 2, 3, lots 1, 2, 3, Dundonald, and the western part of Clergue, contain the main body of the rock mentioned, exposures of which sometimes rise in a sheer wall to a height of nearly 100 feet.

Geology

Serpentine

The oldest rock of the district is the so-called "serpentine," with which the ore-body is associated. It is only exposed in this one place, is of small extent, and reaches a maximum height of about 25 feet above the swamp. Microscopic examination proves the rock to have the make-up of a Wehrlite, but the chemical composition seems to indicate a closer connection with the related group of Harzburgites. At any rate, it is a very highly serpentinized member of the peridotite group. The most interesting feature in connection with the rock, and one which is of great importance in working out the origin of the ore-body, is the porphyritic tendency evidenced by the olivine. The crystals are to a very large extent idiomorphic, and well differentiated from the groundmass. Octahedral crystals of chromite are abundant in the sections, and the chemical analysis gave 1.65 per cent. Cr_2O_3. Like other exposures of serpentine rock in the north country, it is well seamed with asbestos veinlets of moderately good fibre.

Rhyolite

In contact with the serpentine, and probably intruding it, is an exposure of a massive rock. Microscopic and chemical investigation prove the rock to be a rhyolite, with small phenocrysts of quartz, which have been broken, due to mechanical crushing. The rock is quite common in the district, and rises to heights of 75 and 100 feet. No criterion is afforded by which to determine its age, but the field and microscopic characteristics strongly suggest a volcanic effusion of the Keewatin period.

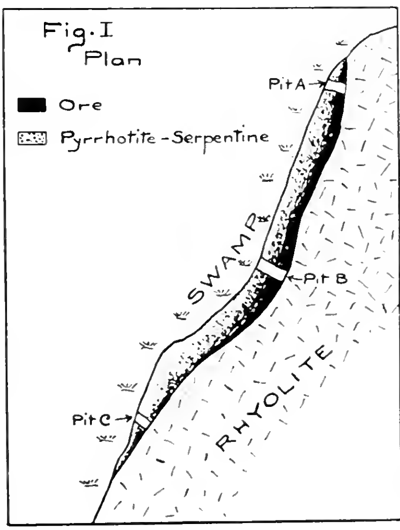
Diabase

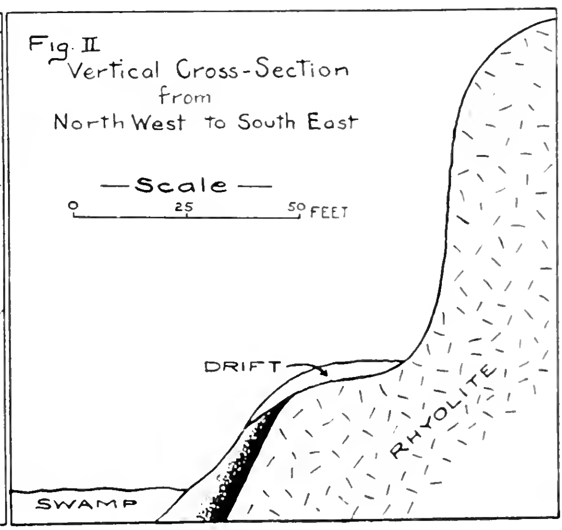
Five exposures of a very coarse grained diabase are found in the area. It occurs in boss-like masses not rising more than 25 feet above the ground. In the polished hand specimen, the ophitic structure is striking, and lath-shaped crystals of labradorite often

half an inch long penetrate the grains of the dark minerals, augite and biotite. The rock is still quite fresh, and in all respects, except the exceeding coarseness of grain, resembles very closely other diabases of the north country. It is quite probable that the age of the rock is post-Middle Huronian, and that the exposures represent the much eroded remnants of a sill.

Occurrence and Nature of the Deposit

The ore-body, as shown in the sketch, occurs on the northwest side of an exposure of rhyolite, measuring about 700 feet by 900 feet, just where the latter comes into contact with the serpentine. The rhyolite rises on its north and west sides rather steeply to a height of about 100 feet out of a flat swampy country, but slopes away somewhat gradually to the south and east, becoming more and more drift-covered. The vertical cross-section (Fig. II.) from northwest to southeast shows the exact position of the ore with relation to the serpentine and rhyolite. Unfortunately, drift covers the contact between these two rocks, except in three places, where pits have been blasted

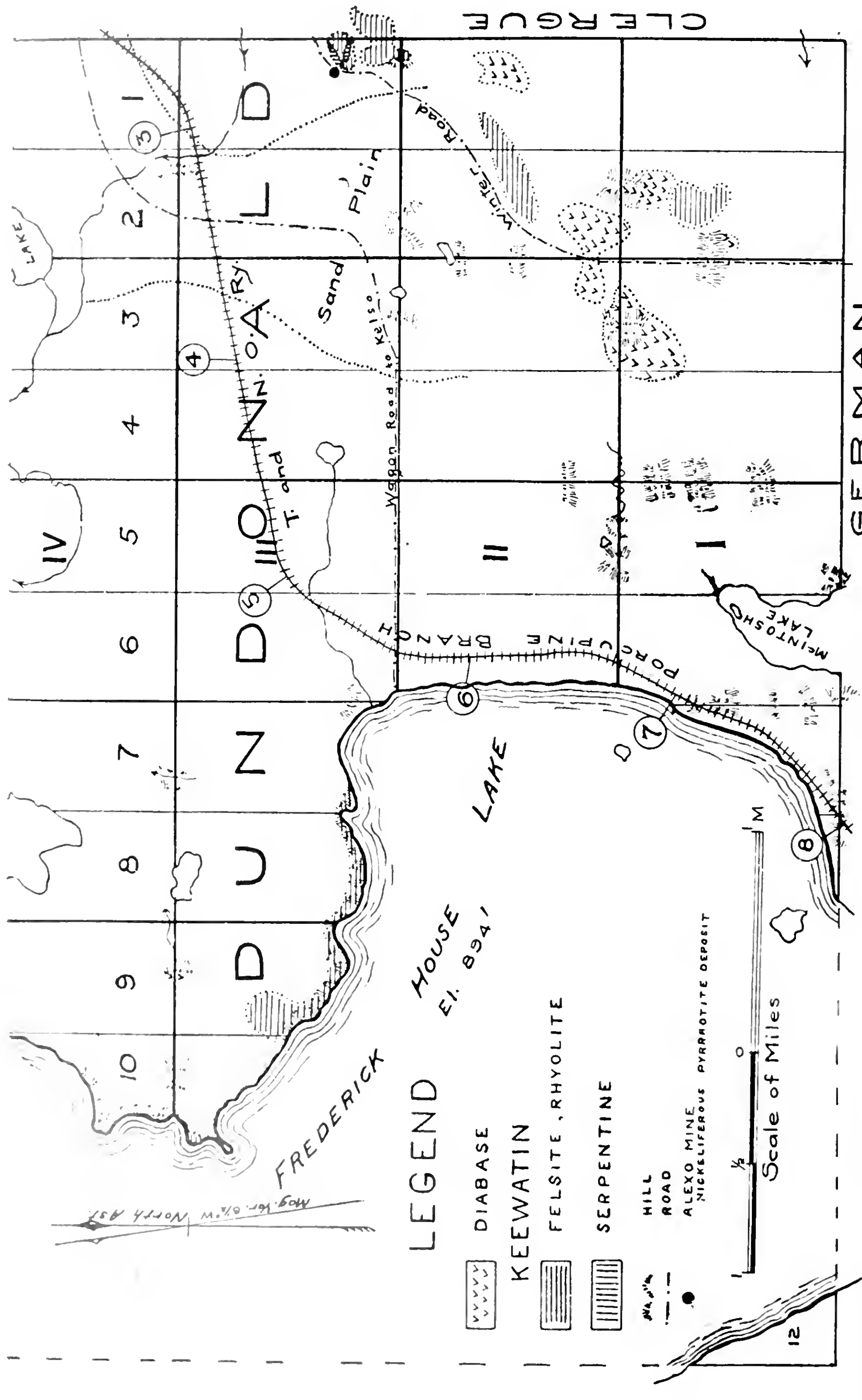




out by the Canadian Copper Company, which held an option on the property. The ore is seen to be associated with the serpentine, rather than with the rhyolite, that is, it lies on the northwest side of the contact. The contact, itself, is quite sharp. Against the wall, there is roughly five feet of solid ore, which then passes imperceptibly into mixed ore and serpentine. This mixture continues for about four feet, with less of ore and more of serpentine to the edge of the swamp. At the south pit, however, very little pure ore is found against the foot wall, and the mixture (or pyrrhotite-serpentine rock) takes its place, being in turn succeeded by pure serpentine. A considerable quantity of good-looking ore has been taken from the pits, and three or four fair-sized dumps stand close by. On megascopic examination, the ore seems to be mainly pyrrhotite, with here and there a little chalcopyrite. The deposit, as revealed on the surface, is about 200 feet long.

In "Economic Geology," Vol. V., No. 4, 1910, a short account of the deposit is given by Dr. A. P. Coleman.[1] His conclusion as to the nature of the deposit is as follows:

[1] See also Vol. XVIII. (1909), Bur. Min., Ont., pp. 23-24.

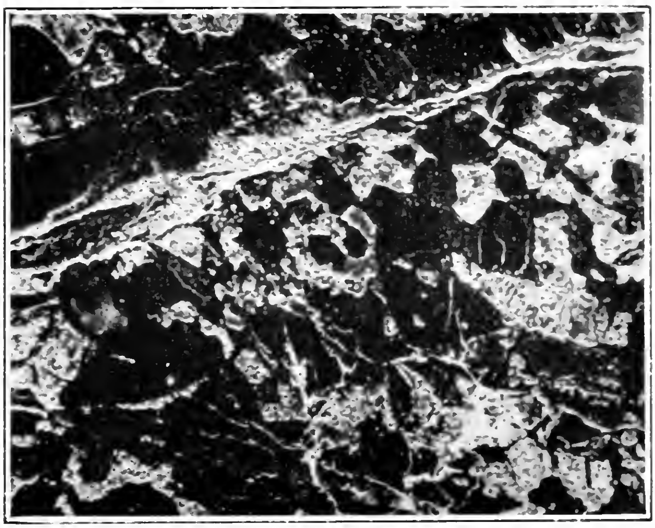

CLERGUE
DUNDONALD
GERMAN
FREDERICK HOUSE LAKE
El. 894
T. and N. O. Ry.
PORCUPINE BRANCH
Sand Plain
Wagon Road to Kelso
Winter Road
LAKE
M'INTOSH LAKE
IV
III
II
I
1
2
3
4
5
6
7
8
9
10
12
LEGEND
DIABASE
KEEWATIN
FELSITE, RHYOLITE
SERPENTINE
HILL
ROAD
ALEXO MINE
NICKELIFEROUS PYRRHOTITE DEPOSIT
Scale of Miles
1
½
0
1 M

"The general appearance of the ore and the arrangement of the ore body suggest strongly the marginal deposits of the Sudbury nickel range. There is every reason to suppose that the Alexo deposit has accumulated in the lower part of a bay-like curve of the country rock while the magma was still molten, as has been proved to be the case with the Sudbury marginal mines."

A detailed examination of numerous thin sections of the pyrrhotite-serpentine rock, taken from rich, lean, and barren spots, was made by the writer; and the results obtained, which are given below, lend considerable weight to the belief that, after all, the deposit is not one of the marginal segregation type, but rather of the replacement type. Polished surfaces of the pyrrhotite-serpentine rock are very similar to those of the augite-porphyrite of the Rossland camp, which has been partially replaced by pyrrhotite.

(1) There is a gradual transition in the amount of ore present, from solid ore against the wall, to pure serpentine ten or twelve feet away.

(2) Idiomorphic crystals of olivine, in nearly all cases completely altered to serpentine, appear to be floating in a matrix of pyrrhotite. The crystal outlines are sharp,



From photograph of polished surface of pyrrhotite serpentine rock. A vein of asbestos is seen crossing the top of the picture. Ore, grey; serpentine, black.

and in many cases perfect, showing no evidences of rounded angles or edges, as might be expected if they had lived for a time in a previously differentiated molten mass of pyrrhotite.

(3) The ore, even in specimens taken from near the wall, shows black six-sided spots scattered abundantly through it, which were originally crystals of olivine, now completely transformed to magnetite. Examples like this seem to indicate pretty strongly that what is now ore was at one time a peridotite of the same nature as the rock about twelve feet from the contact.

(4) The ore is seen to be eating its way through the marix of the serpentine, extending from place to place in bunches of dust-like particles, and veinlike stringers, and eventually occupying all the space in the interstices of the crystals.

(5) The ore also extends from these interstices into fractures in the olivine crystals, finally replacing entire crystals and producing pseudomorphs.

(6) Sometimes the magnetite pseudomorphs, which have resulted from the alteration of the olivine, have become partially or wholly replaced by pyrrhotite.

(7) The serpentine is traversed by numerous veinlets of asbestos. These, of course, are much younger, as regards time of formation, than the rock itself. Nevertheless, in

none of the cases examined, was an asbestos vein seen to cut through particles of pyrrhotite. On the other hand, in nearly every case, small stringers of pyrrhotite run along the sides of the veins and send slender offshoots in between the fibres of the asbestos. This seems good proof that the ore is an infiltration of later date than the formation of the veins. It is also noteworthy that the rock is much richer in ore in the proximity of these asbestos veins, whose walls seem to have afforded channels for the depositing solutions.

(8) Ore is seen to be replacing the secondary pyroxenic material of the contact zone of the rhyolite, but has apparently no effect on the acidic constituents.

(9) Abundance of basic material in the serpentine and the almost total lack of it in the rhyolite, determined the position of the ore body, and accounts for the presence of a definite footwall, and only a commercial hanging-wall.

The Ore

Analyses of specimens gave an average determination for nickel of 7.08 per cent. This high percentage immediately suggested the presence of pentlandite. Surfaces of ore were polished and etched by immersion for half a minute in a boiling solution of HCl. (1:1). The pyrrhotite was, of course, etched, leaving in bold relief, octahedral crystals of magnetite, and delicate stringers and veins of a light bronze-coloured mineral, which proved on analysis to be pentlandite. Some specimens treated proved exceedingly rich in these veinlets, while others showed only traces. In all cases, however, the pentlandite was seen in the form of small stringers surrounding and even penetrating the grains of pyrrhotite. Chalcopyrite is present only in small amount. It is seen under the microscope in small lenticular masses, intimately associated with the pentlandite, and like it remaining unetched. The association is so close that the writer does not feel justified in drawing any conclusion as to their relative ages. The order of deposition which is apparent here is (1) magnetite; (2) pyrrhotite; (3) pentlandite and chalcopyrite. This is in close accordance with the results obtained by W. Campbell and C. W. Knight in their examination of specimens from other localities.[2]

The study of the ore specimens, therefore, tends to further substantiate the theory of replacement for the origin of the deposit. It is difficult to conceive of the sulphides as differentiations from a molten magma, when they were as a matter of fact deposited one after another, the younger occurring as veinlike masses in the older.

Conclusion

The above evidence seems to point without doubt to the origin of the ore-body by deposition from percolating sulphide waters. The source of the mineral-bearing solutions, and the genesis of the nickel content of the ore, it may be difficult to postulate, but two possible explanations are offered by the neighbouring rocks themselves—(1) the analysis of the serpentine shows the presence of small amounts of NiO (0.59 per cent.); (2) in the immediate vicinity are five exposures of a diabase rock, probably of post-middle Huronian age; and in Northern Ontario, the diabase almost without exception carries traces of nickel, as niccolite or cloanthite.

The Alexo Mine is one more example of the almost constant association of nickel ores with some kind of basic igneous rock.

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[2] Campbell & Knight: "On the Microstructure of Nickeliferous Pyrrhotites," Econ. Geol., Vol. II., No. 4 (1907), p. 350.

Photomicrograph of Alexo pyrrhotite-serpentine rock showing vein-like nature of the ore (black).

Porcupine, Government townsite, July, 1910.

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